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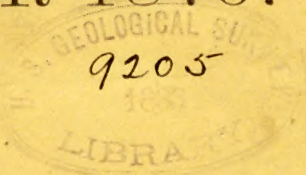
GEOLOGICAL AND NATURAL HISTORY SURVEY.

R E P O R T

ON THE

ROCKY MOUNTAIN LOCUST,

FOR 1876.



By ALLEN WHITMAN, State Entomologist.

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[This work was done at the expense of the State Geological Survey fund,
by order of the Board of Regents of the State University.]

1859

REPORT.

SAINT PAUL, MINNESOTA,
December 23d, 1876. }

Prof. N. H. Winchell, State Geologist:

SIR:—I have the honor to present the following report upon the Rocky Mountain Locust,* as it has appeared in and near Minnesota during the year 1876. At the time of my appointment (in May) to make this report, through the State Geological Survey, there was a hope, and apparently a reasonable one, that the coming summer would close our present opportunities for observing the destructive species of locust, at least as far as our state was concerned. The insects were found to be hatching in a region covering the whole or parts of five or six of our southwestern counties, in a strip of country reaching from Madelia westward across the state, and into two of the eastern counties of Dakota. A few were also found in the northern part of the state in Clay county, and in a few scattered spots in Dakota along the Red river. No other hatching-ground nearer than Colorado was known, and there was reason to believe that the amount of damage resulting from their presence here would be comparatively small, and a fair probability that their swarms would be so scattered and so di-

* The name "Rocky Mountain Locust" is expressed or implied throughout this report. I suppose that every one knows that it is the *Caloptenus Spretus*, or the "grasshopper," that is referred to. Although the name "hopper" holds its place in popular usage, by force of its brevity and euphony, the use of the word locust can occasion no ambiguity, at least in Minnesota. In regard to the latter name, an old etymology is still often repeated, which has done duty long enough. The word locust (Latin, *locusta*.) is not derived from the Latin *locus-ustus*, a burnt place, and that for half a dozen reasons. The root of the word (*loc*) is probably found in the Greek root *lak* (in *lasko*, *e-lak-on*.) and in the Latin *loqu-or*, referring in this case to the chirping or shrilling sound of some insect called *locusta*. Its form is confirmed by such Latin words as *robustus*, *venustus*, &c. See Fick, *Comparative Dictionary of the Indo-Germanic Language*. Part IV, Root (3.)

minished during the summer, that the injury would, for the present, end with the flying season. Under these circumstances, it seemed best to make such additions and corrections to the Report of the Grasshopper Commission of 1875, as the experience of the present year should furnish. But as the season has advanced, and events have multiplied themselves, the subject has assumed, both in extent and urgency, a new and continued importance. Following close upon the attack of 1874, we have a new locust invasion, surpassing all former ones in the amount of territory visited, in the magnitude of the invading swarms, in their repeated comings, and in the length of their combined stay. In addition to the losses inflicted upon the crops during the last four summers, amounting to at least eight millions of dollars, we find the evil still confronting us as in 1873, and while we have gained something by our four years' experience, we have also lost something by the disheartenment which four successive years of damage necessarily bring. To meet in any such report as this the demands of a subject so extensive and important, or the expectations of the large number of people who are so deeply interested in it would be simply an impossibility, but I should be glad if anything contained in it could add to the knowledge necessary for intelligent action, or to the hopefulness which we may reasonably entertain in regard to the locust problem in the long run. Such as it is, the report is the result of several visits to the southwestern counties during the spring and summer, of replies to circulars sent to nearly every infested town in the state, and of a large amount of correspondence addressed freely to various points in Minnesota, Dakota, and elsewhere. To compile such information as could be collected from all these, and from hundreds of items published in our state papers during the summer, has been a work of a good deal of time and trouble. The practical value of the results of work of this kind seldom corresponds to the amount of trouble incurred, but this is simply the fault of the subject.

GENERAL VIEWS ON LOCUST INVASIONS.

Taking into consideration the whole cultivated region from Manitoba to Texas and from the Rocky Mountains to the Mississippi, there have been in the series of thirteen years from 1864 to 1876, but four, (or at most five) years when some portion of this area was not attacked by locusts, coming in from somewhere outside of the cultivated area. In other words there have been no less than nine locust invasions, (differing much in extent and

degree, but still occurring,) in the Mississippi and Red River valleys during the last thirteen years. And these nine attacks stand against some seven or eight recorded appearances of destructive locusts in the same territory during the 46 years preceding, from 1818 to 1864. Again we have on the one hand the sudden appearance of the immense swarms which are said to have overrun a vast extent on both sides of the Rocky Mountains in 1855, the gradual disappearance of their progeny in the course of the next three years, apparently without furnishing material for future invasions, and their continued absence for the next six years. On the other hand we have, since 1864, a series of attacks occurring at intervals of one, two, or at most three years, and apparently of late an annual vibration between the country lying along the mountains and the lower cultivated regions, each in its turn becoming a breeding-ground. The causes of the increase and continuance of the evil of late years lie outside the range of common observation. That they do not result entirely from an increase of acreage under cultivation, is to be inferred from the locust history of other countries, and from the facts that while Central America has suffered from the same evil at least as far back as 1514 (Bancroft's *Native Races of the Pacific Coast*, vol. v., page 601,) and Mexico and California at least as lately as 1855, the exemption of these countries since the latter date has been as noticeable as the repeated devastation of our own vicinity. As for any analogy to be derived from the locust history of European countries the books are not at hand in this state to furnish the exact chronology of the evil; but from such a source as I have at hand, the record of Germany for the last four centuries shows intervals of exemption from injury for eight, twelve, sixteen, forty (1763—1803,) or even fifty (1636—1686) years, and again no less than fourteen years of injury between 1727 and 1755, and among these series of three, four, or even five successive years of damage, as in the five years from 1727 to 1731, and again from 1746 to 1750.*

* These dates are taken from a work entitled, *Die Kleinen Feinde der Landwirthschaft*, by Prof. H. Nordlinger, Stuttgart, 1855, furnished by the kindness of Gustav Kyllander, Esq., of Severance, Sibley county. For a systematic and connected view of the locust evil in general see a paper contained in the Report (for 1876) of the Hon. Commissioner of Statistics of Minnesota, Dr. J. B. Phillips. Notice is particularly called to a chronological table published therein. It will be seen that there is no state or territory west of the Mississippi that is not in the "grasshopper regions," and no year since 1863 that has not been a locust year. The year 1871 should be included in the table, for reasons stated in this report.

The locust problem still presents a great deal upon which nothing like complete information has been furnished. Even in regard to the locust as it appears in our own State, not only does the farmer ask many questions, to which the entomologist can as yet give no decisive answer, but even in the practical economy of the locust question opinions are still at variance, where experience should, by this time, have brought some degree of unanimity. When it comes to the exact origin of our invading swarms, their manner of increase from year to year before leaving their native regions, their growth, habits, and movements in those regions, how far eastward those regions may or do extend, the causes of the repeated appearance of migrating swarms, or their continued absence for years or even decades, no one can at present offer in answer much more than a mere show of probabilities. It is evident that the whole question is becoming too urgent to wait for private investigation to solve it. The claims which an agricultural population of at least thirteen States and Territories may justly urge upon the National Government in this regard, have been fully set forth during the past season ; but purely in the interest of science, if for no other reason, we might fairly ask that some portion of the sums annually devoted to national discovery might be expended upon the further elucidation of a subject which touches us so nearly and so powerfully. Having at hand the time, the place, and the opportunity, we might at least attempt the solution of some questions which the Old World has been obliged to leave unanswered for a thousand years. We might, perhaps, learn enough of the causes of locust invasions to know in what years such invasions would become probable, and enough of their origin to say whether prevention is possible or impossible.

THE EVIL AS IT APPEARS IN MINNESOTA.

The growth and habits of the young locust as it appears in the cultivated regions, have been so fully described of late years, (particularly in the seventh and eighth annual reports of the State Entomologist of Missouri, Prof. Ch. V. Riley,) that it seems impossible to add much that can contribute to that practical end which the farmer has in view, the protection of his crops from the locusts which hatch in his immediate vicinity. If anything practical is still to be expected in this direction it ought to come from those who are brought face to face with the young locust, and are obliged to act upon knowledge gained upon the spot. Enough has been learned already to make it certain that almost

any community may, by enlisting all the forces at its disposal, effect a measurable saving of its crops, and that the evil, if it could be confined to the locusts that hatch here, might be practically eradicated in a few years at most. But there is a growing apprehension in the minds of the people of Minnesota, brought about mostly by a consideration of events occurring in our own state only, and that too only within the last four years, that we are more liable to locust invasions than other states; that the locust evil may become a permanent one here even without reinforcements from abroad, and that its area may gradually extend until it covers regions still unknown to it. This apprehension is increased by the fact that the invasion of the present year has reached, (to the south of St. Paul,) about one degree of longitude further east than it has ever been known to extend before. It is possible that Minnesota may, from its geographical position, suffer from locust invasions more frequently in the long run of fifty or a hundred years than Kansas or Manitoba, though a history of the last twenty years shows no special preponderance in favor of either state; it is possible that its cold climate, and the high and dry soil of its southwestern counties may furnish a more congenial and permanent home to the swarms that breed here, though the events of the last four years, when fairly considered, show that even here there is a constant decrease in the numbers of such swarms as remain; and finally the history of the whole Mississippi Valley shows that the Rocky Mountain Locust is confined on the east by a tolerably well defined limit which up to the present time, neither invading swarms, nor their progeny have essentially altered. Upon all these points the Entomologists are repeatedly called upon to express their opinions, which have been freely and in most cases cautiously given; and these opinions are in turn repeatedly called into question by those who persist in mistaking opinion for prophecy, or in applying a general rule to a limited area, or to a particular year. But it is evident that there is still room for the study of the physical character of the locust, and of the geographical, geological, climatic or other causes by which it is influenced.

HISTORY OF PAST INVASIONS.

Until within the last four years the migratory species of locusts has been so infrequent and transient a visitor in Minnesota, that the details of its former visits are almost forgotten. There is no definite knowledge of any such visit down to the year 1855, unless

the ravages committed in the Red River Settlement in 1818 and 1819 may be said to concern this State. But the statement of Capt. Jonathan Carver in 1766, in regard to the large swarms which "infest these parts and the interior colonies" shows the occasional presence of the migratory locust, although it is hard to say exactly what localities are referred to. But late in July 1856, invading swarms came from the Northwest into the Upper Mississippi Valley, and gradually spread along the river during the season, much the same as they have done in the past summer, and reaching nearly the same limits. The injury was, of course, felt most severely along the Mississippi and the cultivated region adjacent, but the locusts are said to have appeared along the Minnesota River, in the Yellow Medicine country, and at various points in the north western counties of the State. It is probable that the north western part of the State was swept over by migrating swarms during the summer, much the same as in the present year. But few traces of these were seen in the following year, except along the Upper Mississippi, where the damage was even greater than the year before. A general flight took place in July, and the direction of the departure was to the south and south-west generally, and was, perhaps, the occasion of the injury done in Iowa that year.

Again, in 1864, swarms appeared early in July, along the Upper Minnesota river, and spread eastward gradually during the season, and reached about as far east as in 1874, *i. e.*, to the third tier of towns in Le Sueur county. Scattering swarms also visited Manitoba in the same year, and probably some portions of these reached as far as Minnesota, for we hear of slight appearances of them in the Red River and the Sauk Valleys in 1864 and 1865. But the greater portion of the injury was done in the Minnesota Valley, and was followed by a general departure to the southwest in 1865. The injury in Colorado also was very severe in the same years, but there seems to have been no large movement to the eastward, such as occurred later, in 1866 and 1867.

It seems very likely that the swarms which entered Minnesota in 1864 were hatched at no great distance, and were the offspring of swarms that had alighted in eastern Dakota in the preceding year. This may perhaps be inferred from the following letter of the Rev. S. R. Riggs, missionary at the Sisseton Indian Agency, dated Sept. 9, 1875:

"In 1863, it will be remembered, that on Gen. Sibley's expedition to the Missouri we met with the *ravages* of the grasshoppers in various parts of Dakota, particularly, as I remember, near Skunk Lake (in Minnehaha coun-

ty) where the large grass had been eaten to the bare stalks, and our animals fared badly.

"In 1865, I visited a camp of Dakota scouts, near the "Hole in the Mountain," at the head of the Redwood. That was in the month of August. The valley of the Minnesota clear out to the Coteau was so full of grasshoppers as to make it unpleasant traveling. For the next four years, I traveled every summer on the Missouri River, coming over to and from Minnesota. Every season I met with grasshoppers at some point on the east side of the Missouri. In 1867, and also in 1868, we found them near Fort Randall. In 1869, in August, we met them above Fort Sully, near Grand River. In all these cases, they were only in small battalions, and appeared to have come there from other parts."

Again, in 1871, slight and scattering swarms of locusts appeared in Stearns, Todd, Douglas, Pope, Otter Tail, Becker and Polk counties, and perhaps in others. In all these counties they were in sufficient numbers to make themselves noticeable, and in some cases crops were injured, or a few eggs laid; but the occurrence would have been mostly forgotten by this time if they had not been brought to mind by more recent events.

The invasion of 1873 was something unusual in its character from the earliness of its arrival, the direction from which it came, and from the fact that it was the beginning of a visitation which has been prolonged to the present time by what, judging from former years, would appear to be unusual circumstances. Each summer since 1873, instead of being the scene of a general departure of the hatching swarms as in former years, has seen portions of those swarms alighting but a few miles from where they were hatched, (generally in the next range of counties, and sometimes in other parts of the same county,) and depositing eggs for another brood. In addition to these, new swarms coming in from the northwest in 1874 and again in 1876, have added greatly to the area of devastation in both these years, and in the latter year to the area of egg-deposit, so that the prospect of destruction to the crops in 1877 is greater and surer than ever.

MINNESOTA AS A BREEDING GROUND OF THE LOCUST.

Without saying anything for the present about the new coming swarms, the history of those that have bred inside the State since 1873 has been as follows: They reached the southwestern corner of the state about the first of June, 1873, brought by a wind that had been blowing freshly from the southwest for several days. During June and July, they spread themselves over the whole or portions of fourteen different counties, lying adjacent to each

other, and throughout all this area locusts were found to be hatching in 1874. On acquiring wings, these flew northward early in July, and portions of them alighted in the range of counties next beyond those they had already occupied, leaving vacant the ground they had covered on hatching. By the 15th of July they had entered Blue Earth, Nicollet, McLeod and Renville counties. By the latter date, new swarms had begun to pour in from the northwest, and passed over the western counties to the southward. That these additional swarms did not add much to the stock of eggs deposited by our own broods is probable, for two or three reasons; first, because their progress, so far as it could be traced, was entirely across the state, and across most of western Iowa, before laying eggs; and secondly, because the principal hatching-ground of 1875 was precisely in those counties which had been already occupied by our own stock in 1874 (before the arrival of new comers) with some slight additions to the eastward. Eggs were also laid, later in the season, in scattered spots in some of the northern counties, and in six towns in Meeker county, by swarms coming in from the northwest about the first of August. But the greater portion of the locusts hatched in 1875 were found along the Minnesota River, and these on flying moved southward, and alighted in the range of counties next beyond those they had just occupied, where they remained and deposited eggs during July and August. Of the swarms hatched from these last spring some flew away to the southward early in July, while others flew northward, some alighting along the Minnesota, and others moving still further north. Other swarms also came from the west, from the Red River valley, into several of the northern counties, and were probably a portion of those that hatched along the Red River. By the 10th of July all these had made their appearance in thirteen counties besides those in which they were hatched, but generally in small and scattered bodies, and in only two or three towns in a county; they were most numerous in Renville, Douglas, and Otter Tail counties.

The object of the preceding paragraph is to show that it is probable that the locusts which hatched in Minnesota last Spring were to a considerable extent the descendants of the swarms which entered the State in 1873. However unimportant it may seem, it has a certain value if it enables us to judge of the effect upon the Rocky Mountain locust resulting from a four years' continuous breeding in our climate.

DEGENERATION.

So much has been said of late years of the tendency of the migratory locust to "degenerate" in the more easterly and southerly portion of the area visited by it, and this theory has been considered by our people so complete a failure, that it is worth while to state exactly what the theory is, and how truly it applies to our state. It might have been submitted at the start that opinions based upon a consideration of events still occurring, and more or less liable to be modified by new circumstances, should not be pressed too far nor too literally; and it was just that in judging as to the correctness of these opinions, that they should have been fairly stated. I give them in the briefest form in which I find them: "There is nothing more certain than that the insect is not autochthonous in West Missouri, Kansas, Nebraska, Iowa, or even Minnesota, and that when forced to migrate from its native home, from the causes already mentioned, it no longer thrives in this country." (Riley's seventh annual report, p. 165.) It will be noticed that Dakota and Colorado are not included in this list; that Minnesota is to some extent excepted, and that, though not directly stated in the sentence quoted, the application is to swarms breeding one year after another in the regions mentioned, and not to such fierce hordes as have swept down upon us from the northwest in the summers of 1874 and 1876. The discouraging events of the last four years have served to confuse the question, and it is no wonder that our farmers, seeing the considerable numbers that have remained to breed here from one year to another, with the intolerable numbers that have been added in two out of four seasons, should come to believe that Providence has given over one half of our state to be henceforth the perpetual home of the locust. We have a series of occurrences so different from those of Missouri, Kansas and Nebraska, that it seems hard to account for them on any basis of mere accident or of which way the wind happens to blow when our swarms are ready to migrate.

The winds which sweep clean away the hatching swarms of the more southern states carry our own but a few miles from their birth place. It is evident that they are not detained here merely by abundance of food, for the swarms of Kansas and Missouri leave behind them fields as rich as ours; nor by force of winds, for the same winds that bring down upon us invaders born hundreds of miles away, and carry them across our state and into more southerly regions, might also carry with them the broods of our

own hatching. I believe it is not as yet fully known what connection there may be between the migrations of the locust and its season of egg-laying, but it seems that some cause for the fact that portions of our swarms remain here to breed can be found in an early stage of egg-laying. Here again we have a difference between our own broods, and not only the new swarms that come in upon us from the mountain regions, but also those which leave the more southerly regions and fly to the northwest on acquiring wings. As for the latter, in the flight from the Missouri Valley northward in 1875, Prof. Riley was able to learn of no case of their depositing eggs, nor were the hatching grounds, (outside of Minnesota,) of last spring found to be anywhere in the vicinity of those of 1875; as for the swarms that have descended upon us during the summer, I have not been able to learn of any deposit of eggs whatever in any of their stopping places on their way toward this state, and even on arriving here it was evident in most cases that they had not yet reached the season of egg-laying. Between the 17th and the 31st of July there was a gradual movement, apparently of new-comers, across the state towards Iowa, and the egg-laying did not become general until about the latter date. Between the first and sixth of August other swarms came in, and these again in most cases did not begin to lay until a week or more after their arrival. Still others came in later, and the laying was kept up until late in September and was seen to occur in October, or as long as the locust remained alive. On the other hand our own stock were seen in 1875 to be laying within eight days after their flight commenced and in the places where they first alighted, and during the past season the laying had already begun on the third of July and by the tenth had become general in the western part of Nicollet county, within a few miles from their hatching-ground, and within two weeks from the time when the flying began. This early period of laying may be of itself a sufficient cause for portions of our swarms remaining here, while the less mature pass on.

NATURAL DECREASE FROM ONE YEAR TO ANOTHER.

But though portions remain, there is no increase in their numbers from one year to another. So far from holding its own, the locust has seen its breeding grounds decrease from nearly fourteen counties in 1873, to some seven and a half counties in 1874, and about five and a half counties in 1875; and in this latter area though able to inflict serious damage in many places (owing chiefly

to the small acreage planted) they were in other places noticeably fewer than in former years.

This continuous decrease in numbers has resulted from several causes, and the first of these is the early stage of laying just alluded to, by means of which large numbers of locusts have hatched out during the last two autumns, and have died without reproducing themselves. In this connection, the state of Minnesota has an advantage over more southerly regions, in the fact that we are situated nearer to the breeding-grounds of invading swarms. Of these the earlier comers are more likely to pass over us before reaching the full period of their development, while the later comers are cut off by our earlier frosts; and of the eggs which are left with us, being deposited earlier in the season, more are likely to hatch in the fall and become harmless. On the other hand, the invaders are more likely to mass their forces in more southerly states, reach them in full maturity, and remain later in the season, while the eggs, being deposited later than ours, remain mostly unhatched until spring. These considerations enable us to understand why certain counties in Missouri, where the locust hatched in 1875, presented in May such a picture of devastation and desolation as Minnesota has never seen in all its locust experience.

But while becoming prematurely developed, (if this is a correct expression of the facts as stated,) the locust had also become shorter lived. One year ago, there was hardly such a thing as a Rocky Mountain locust to be found in Minnesota by the first of September. The swarms that had hatched along the Minnesota river in the spring, and had alighted but a few miles further to the south in July, had almost totally perished in August, without extending the territory of their occupation more than the width of one county beyond the area which they covered on alighting. And in this connection we owe more to the *Tachina* maggot than many are willing to allow. But of the invading swarms of the present year, though large numbers of the bodies of the dead could be found in the fields early in September, (something unusual, from the fact that heretofore they have hardly ever been found at all,) large numbers remained alive until they were killed by frost, and even then died with eggs unlaidd.

Still another effect of naturalization during the last four years is an apparent change in character, slight in itself, but showing what the tendency would be if the locust were to continue to breed here. While it has lost some portion of its inclination or its ability to migrate, it has also lost somewhat of its gregarious character. This was shown by the young locusts last spring, moving over the

fields in scattered bodies, or in no bodies at all, a peculiarity so noticeable as to attract the attention of the farmers ; by the movements of the swarms on leaving their hatching-grounds, in small squads and in various directions ; and by the fact that where they alighted first they left their eggs promiscuously here and there in the grain fields, instead of in bodies and in selected spots as heretofore. There was no general flying from their hatching-ground in large bodies, mostly in one direction, as was the case in 1874 and 1875. By the last week in June they began to leave some places so imperceptibly that their departure could hardly be seen, though their numbers were noticeably diminished. For the first ten days of July, small squads went careering up and down, south of the Minnesota river, and wherever there was anything like a movement of large bodies they seem to have left the state to the northwest, west, and southwest. In the meantime, others had spread themselves northward towards the North Pacific Railroad, and had alighted here and there in numbers sufficient to do considerable damage. But, judging from the occurrences up to the 10th of July, had it not been for new-comers, next year would have seen the insects so few and so scattered as to be incapable of great damage, and they might become, in a year or two, as flitting and as unnoticeable as the red-legged locust that breeds with us every year.

Probably this is all that can be made of the "degeneration" of the locust so far as observed in Minnesota. It had not become so impaired in strength nor so diminished in numbers as not to prove a serious evil wherever it alighted or laid eggs. It was however decreasing in numbers, and gradually becoming less capable of reproducing itself. . Something might perhaps be added in regard to changes in color and appearance; while the locusts which hatched in Minnesota last spring had when fully developed something of the darkness and dullness of old age, the brightness and fierceness of the fresh invaders was apparent to every one.

The facts stated show the general tendency, but there is a more vital question than the tendency of the locust to degenerate here. How long the state will continue to be one of the breeding-grounds of the locust, is simply how long new hordes will continue to sweep over us and leave here fresh seeds of future devastation. Nothing is more certain than that we might, by general and continued effort, practically eradicate the offspring of almost any one year's invasion; nothing is more probable than that in almost any season, the whole body of our hatching swarms might be utterly swept away from our midst by favorable winds; and finally,

if we may judge from the last four years, our breeding-swarms would decrease gradually from one year to another, and if not reinforced from abroad would finally become so few and so scattered as to be harmless.

ANNUAL DEPARTURE OF LOCUSTS.

Besides the causes already mentioned, still another has been found in the impulse which moves the locust to leave its birth-place on acquiring wings. The considerable numbers that have remained behind each year, have created the impression that none were gone, and that the locust had become a permanent appendage of the state. But a collection of various items for the last three years, together with letters received from the eastern tier of counties in Dakota, shows that considerable numbers have left the state, generally to the northwest in 1874, and in various directions during the past summer. But, with Dogberry, we have been content to "take no note of him, but let him go, and thank God we were rid of a knave." It is only within the last year or two that it has become fully apparent that the final destination of these departing swarms is an important consideration, and one which serves to complicate the locust question more deeply than ever.

Whether or not it is a general rule that the locusts on acquiring wings seek the direction from which their parents had come in the preceding year, (a rule which the experience of Minnesota fails to substantiate,) it is at least certain that in 1875 "the main direction taken by the insects that rose from the lower Missouri valley country was northwesterly." (Riley's 8th Ann. Report, p. 105.) These swarms were traced by Prof. Riley, moving northerly from the end of May, through June and into July, and passing various points in Dakota, Wyoming and Montana.*

They passed northward over Bismarck at various times between June 6th and July 15th. (Same report, p. 86.) But a still more definite statement as to the final destination of these northward moving swarms is found in an editorial of the *Winnipeg Stand-*

* He adds (page 108) "nor can I learn of any instance where these swarms that left our territory deposited eggs." The different case of our own breed of locusts, laying eggs within two weeks after the flying commences, is remarkable. But I am informed by Captain J S Poland, commanding at Standing Rock, that a swarm from the south alighted near that post, July 4th, 1875, and deposited considerable quantities of eggs between the 4th and the 18th of July.

ard, of August 19, 1876, entitled "Locust Flights:" It is there stated that

"The locusts which hatched in Missouri, Kansas and Nebraska, in an area of 250 miles from east to west, and 300 miles from north to south, took flight in June, and invariably went northwest, and fell in innumerable swarms upon the regions of British America, adjoining Forts Pelly, Carlton and Ellis, covering an area as large as that they vacated on the Missouri River. They were reinforced by the retiring column from Manitoba, and it seemed to be hoping against hope that the new swarms of 1876 would not again descend upon the settlements in the Red River valley. Intelligence was received here that the insects took flight from the vicinity of Fort Pelly on the 10th of July, and then followed a fortnight of intense suspense."

There is of course in all this a failure to connect by any direct chain of continued observations the swarms that left the Mississippi valley in 1875 and those which finally disappeared in the region of the mountains and in British America; still less is it shown that those swarms were the parents of those which are known to have hatched in the same regions in 1876, or even that those which are known to have hatched there were those which descended upon the lower country in July and August. But there is at least a strong series of probabilities.

A great deal has been said within the past two years about the practical help which the general government may perhaps find itself able to extend to the people of the Mississippi valley by attacking the locust in its native breeding-places, and it has been considered possible that some means might eventually be discovered of preventing or at least mitigating such inroads as that which has just ended. But if the events of 1875 and 1876 have any such connection as is claimed for them in the preceding paragraph, if the more northern and western breeding-grounds of the locust are recruited from the lower cultivated regions in alternate years, the problem of how to give practical help to the farmer will be greatly simplified. It would be hard to imagine a method of extirpating the swarms or the eggs of a hurrying insect from an extended area, or perhaps several such areas, of mountains and deserts, the resort of wild beasts and savages, where only armed bands can maintain a foothold; and on the other hand it would be hard for the government to find a time better fitted to begin the extermination of the locust than when the mountain region must be measurably depleted of its stock, nor a place better situated to the warfare than a region where, with any fair assurance of conquering a peace, every inhabitant stands ready to do battle.

STARTING POINTS OF INVADING SWARMS IN 1877.

Besides the region in the article above quoted from the *Winnipeg Standard*, various parts of Montana are known to have been considerable hatching-grounds during the past spring. In the *Bismarck Tribune* of June 14th is found the following, which is quoted because it gives an idea not only of the place but of the nature of a breeding-ground :

“IN THE FIELD, NEAR ROSEBUD BUTTES, May 29, 1876.

“As we move westward the grazing improves, and here in the Little Missouri Valley the season is at least a month in advance of the season on the Missouri. This would be a splendid grazing region, were the water good. The grass is heavy and nutritious, but the water is strongly impregnated with alkali. Millions of locusts are just now making their appearance in this region. Too young to fly or do much harm, in a few days, should the winds favor them, they will sweep down upon the defenceless agriculturalists on the border, doing untold damage.”

Officers who passed over the country between the Little Missouri and the Yellowstone rivers during the spring, state that at various points in that region young locusts were found in immense numbers. Shortly before the 23d of July, migrating swarms of locusts appeared in the vicinity of Gen. Crooks' camp; “myriads of grasshoppers filled the air, appearing like an immense drifting snow-storm, trending toward the southeast, and apparently taking advantage of a northwest wind to favor their flight to the same fields that they have effectually devastated for two consecutive seasons.” (Extract from a letter of July 23d, quoted in the *Pioneer-Press and Tribune*.)

MOVEMENTS OF SWARMS OUTSIDE OF MINNESOTA.

It is difficult to show any eastward movement across Dakota of these swarms that hatched in Montana. At Standing Rock, the movement was from the north. On the 19th of July, quite a large number were observed coming from the north, and by the 26th had about all disappeared from the vicinity of that station. Capt. Poland states that the main body appeared to pass to the west of that station, moving south. No eggs were laid at Standing Rock, or in the immediate region. At Fort Sully, as shown by the records of the Signal Observer, the locusts appeared at various dates from the 14th to the 30th of July, and again from the 10th of August till September 2d ; but whenever the direction of their

flight is given, it is to the northwest. No eggs were known to be deposited there. At Lower Brule Agency, on the 29th of July, an immense swarm alighted from a westerly direction, and flew again to the northwest, after remaining five days. At different times during the month of August, small swarms, coming from a westerly direction, alighted and died there. No eggs deposited. At Yankton, the course was generally south, through the flying-season.

It is probable that both in 1874 and 1876 the swarms that came into this state, at least in the earlier part of the season, were hatched in or near British America. This is to be inferred from the direction of their coming, the fact that we know of extensive hatching-grounds in British America in both these years, and that we know of no nearer hatching-ground. There is here also a failure to connect Minnesota with any known breeding-place by any continuous observations. But it is known at least that at Bismarck swarms passed south at various times during July. At Jamestown, (on the N. P. Ry., east of Bismarck,) a large swarm coming from the northwest on the 12th of July, dropped and remained until the 24th when they left, going south. On the 14th of August a very large swarm passed over southward without alighting. At Worthington, D. T., (still farther east, on the Northern Pacific Railroad,) the first flight appeared from the south on the 25th of June, stayed about 24 hours and on a change of wind went south. For the next six weeks locusts passed over that station in various directions.

At Fort Totten, "in the summer of 1875, grasshoppers hatched in the vicinity of the post, took wing in June, and left in the beginning of July. In 1876, there was no hatching, but they came and departed without doing material damage. They always go and come with the wind. They came about the middle of July, and left in about four days; came again two weeks afterwards and left without depositing any eggs. Swarms generally came from the northwest. They often pass over in large numbers without doing damage."

L. C. HUNT,
Lieut. Col. 20th Inf.

ENTRANCE OF INVADING SWARMS.

The rate at which swarms have been pouring into the state during the summer, may be judged from notes taken at points along the western line of the state of Minnesota, and from the eastern tier of counties in Dakota. I give them in regular succession, from Pembina southward:

Pembina, D. T., Aug. 31, 1876.—“No locusts hatched near here, and no eggs now deposited.”—W. R. Goodfellow.

July 8.—“Grasshoppers first observed to-day. They could scarcely be seen with the naked eye, but by using colored eye-glasses they were made plainly visible. They were in great numbers, flying very high, far above cumulus clouds, and in a northeasterly direction.”

July, 9.—“Grasshoppers flying northeast.”

July 11.—“Grasshoppers, flying high, and moving southeast, were observed in great numbers.”

July 12.—“Grasshoppers still appear moving south-southeast, flying very high; can scarcely be seen with the naked eye.”

July 13.—“Grasshoppers still continue to be seen moving south by east.”

July 17.—“Grasshoppers noted to-day, moving southeast, in greater numbers than heretofore, and flying considerably lower. None have as yet alighted.”

July 20.—“Grasshoppers continue to fly over this place, moving from the northwest.”—Records of the Signal Observer, J. Kabernagle.

Grand Forks, Grand Forks county, D. T. (nearly opposite Crookston) Aug. 28, 1876.—“A few locusts were hatched here and flew to the southeast early in July.

“A few lit on the 9th of July. They came from the north before alighting, but on the 8th the same grasshoppers flew north and returned next day, a few alighting, and all left on the 10th, without doing any injury—direction southeast.

“From the 10th, all through the month of July, when the weather was fine and clear, and the wind from the north or northwest, more or less of them flew over, moving in a southerly or southeasterly direction. But in no instance have I seen very heavy clouds of them until the 4th and 5th of August, when I was out on the head waters of the Turtle and Big Sault, from thirty-five to forty miles west and northwest of this place. I saw them moving in a southeasterly direction, in thicker and heavier clouds than I ever before saw grasshoppers flying. On the evening of the 5th it rained, and a considerable portion of them fell, and rose next day, moving in the same direction as before. And, strange to say, they rose without much sunshine, as the day was cloudy, and the sun showed itself only at intervals, and that for a few minutes at a time. I never saw them move before except upon a clear, sunshiny day, with a wind favorable to the direction in which they wanted to move. None lit near the Red river at this time.

“I do not think that any eggs have been laid here by those alighting in July, nor by those alighting on the 5th of August, west of here thirty-five or forty miles.”—Hector Bruce.

Crookston, Polk Co., Minn., Sept. 2, 1876.—“On July 10th and 11th, swarms of ‘hoppers came from the southwest, and lit at Crookston and vicinity, remaining two and a half days, and without doing any damage worth noticing; they were pairing. They got up on the third day, and went northeast. Three days later, a large swarm passed over us, going east of southeast, coming from the north. July 31st, a few lit here from the west, but doing no damage. August 10th, a few straggling ones came from the north, until August 15th, when they disappeared, going south.”—Ross and Walsh.

Caledonia, Traill Co., D. T., (a few miles south of Crookston,) Aug. 30th, 1876.—“No locusts hatched here in the spring, nor were any eggs deposited. They began to fly over about July 5th, generally going south or southwest, and for ten days there was hardly a day but what we could see some flying, most always going south.”—Ara Sargeant.

Fargo, Cass county, D. T., Aug. 31, 1876.—“A few locusts were hatched here, and flew northeast on acquiring wings. A large swarm alighted on the 18th, and remained two days, without doing much damage. During the last half of July, and until August 5th, extensive swarms were passing over this county. Their destination was determined by the direction of the wind, either northwest or southeast.

“I cannot learn that any eggs have been laid here this season.”—A. J. Harwood.

Breckenridge, Minn., Sept. 27, 1876.—“Grasshoppers hatched here from May 23d onward.

June 27.—“First seen flying to-day, few in numbers, going with the wind, from northwest to southeast, between 11 A. M. and 2 P. M.

July 4.—“Flying in great numbers this forenoon from 9 to 11:30, going from the north with the wind.

July 11.—“Hoppers coming down in swarms this forenoon, and flying from the north.

July 12.—“Hoppers left to-day, going south, as there was a strong wind blowing from the north all day.

July 19.—“Hoppers flying from the northwest to-day, in millions. Seen first about 9 A. M., and kept going until sundown; largest swarm seen yet, and looked like a great drift of snow.

July 22.—“A few hoppers seen to-day, flying between 10 A. M. and 3 P. M., from the north, slowly.

July 23.—“Hoppers flying from 9 A. M. to 5 P. M., from the north and northeast, but not in great numbers as on other days, none of them coming down.

July 24.—“Hoppers returning to-day, coming from the southeast, flying with the wind; began moving about 10 A. M. and till 4 P. M. None came down.

Aug. 1.—“Hoppers have appeared again in millions, coming from the north; are destroying the crop in Minnesota and Dakota. But few of them are rising to-day, as the weather is cloudy.

Aug. 3.—“Hoppers still remain, and are destroying everything, crop, vegetables and grass. A few seen flying during the entire day, from the southeast.

Aug. 6.—“Hoppers began to leave about 10 A. M., going southwest; wind very light, and from the west. First seen depositing eggs to-day.

Aug. 7, 9, 10, and 12.—“Hoppers seen flying in small numbers from the southeast; still remain here, depositing eggs.”—From the Records of the Signal Observer, M. L. Hearne, M. D.

Wahpeton, Richland Co., D. T., (opposite Breckenridge,) Aug. 30, 1876.—“A few locusts hatched here; so few that the dates of their hatching or

departure was unnoticed. Eggs were laid only in scattering spots, after August 1st. They left before the egg-laying was finished."—D. Wilmot Smith.

Sisseton Agency, D. T., (opposite Big Stone Co., Minn.) Aug. 12, 1876.—“In the upper portions of the Reservation, twenty-five miles north of the Agency, a small quantity of grasshoppers were hatched, in the latter part of May, and destroyed several grain fields and gardens. At different times in the month of July, we saw them flying over, sometimes in large numbers. Only a few straggling ones came down. The direction has generally been from a point south of southwest.

“On Sabbath, the 30th of July, we had a visitation all over the Reserve. They came down like snowflakes in winter, and covered the earth. Garden vegetables, especially beans and onions, were eaten up to the roots. Corn was pretty much destroyed, and potatoes and oats were very much damaged. The wheat was generally ripe, and but little eaten. They commenced leaving about twenty-four hours after they came, but it was the last of the week before we were free from them. They left on the same line on which they came, going towards the northeast or east of northeast. They were probably the same that have lately visited Herman and Morris, on the St. Paul & Pacific Railroad. I understand they were quite as thick to the west of us, twenty miles, as here.”—Rev. S. R. Riggs.

[These swarms appear to have reached Ortonville, Big Stone county, about the first, Herman on the third, and Morris on the fifth of August. They came eastward from the James river. The settlers along the James river state that no locusts were hatched there, and that all that appeared there during the season came from the northwest.]

GARY, DENEL CO., D. T., (Opposite Yellow Medicine Co., Minn.) Dec. 8th, 1876. “No locusts were hatched in this county last spring. The first flying swarm appeared in the latter part of June, flying northwest and did not alight. July 20 a very large swarm came from the southwest and went northeast; a few stopped and remained about 24 hours.

“August 15, they flew very thick, the largest swarm I ever saw. They came from the northwest and flew southeast. This swarm, as near as I can learn, was about 20 miles wide. [This probably furnished a portion of the swarms which reached Le Sueur, Mankato, and other points to the east and southeast on the 18th of August.] August 19th a swarm flew from north to south. August 24th a small swarm passed from northwest to southeast; and again in the same direction on the 30th of August. On September 4th, 5th, 7th, and 9th small and scattering squads flew over to the southeast.”—H. H. Herrick.

Medary, Brookings Co., D. T., (opposite Lincoln Co., Minn.) August 30, 1876.—“The hoppers hatched last spring in this county and the northern half of Moody county. These became fully developed from the 25th of

June to July 1st, and on the days between those dates they left in great clouds. The favorable winds for them seemed to be from north, northwest or northeast. They seemed inclined to go southwest.

From July 1st until now the hoppers have been seen flying overhead nearly every day, moving with the wind, most numerous always with northerly wind. These alighted only once or twice in July, but only in small numbers, and remained only a short time.

On Saturday, July 22d, very dense clouds passed over, (some so low as almost to darken the atmosphere,) with a northeast wind. They were going west. I have since learned that they rose from Minnesota, from the State line eastward.

On Saturday, August 5th, very great swarms passed from west to east. At that time many alighted on the prairies, but not many in the settlement. The next morning, Sunday, I drove from Medary to Oakwood, about 18 miles north, and when about half way, I could see, for a distance of thirty miles up and down the valley of the river, dense clouds of hoppers rising. I have since learned that they extended more than 40 miles south of here, and I know more than 20 miles north, making a belt more than sixty miles wide.

"These I note as remarkable displays of hoppers. They could be seen every day, in what any reasonable man would call sufficient numbers. No eggs were laid in this county so far as heard from."—Rev. G. S. Codrington.

Flandrau, Moody county, D. T. (opposite Pipestone county, Minn.) Sept. 12, 1876.—"A few hoppers hatched here, but did little damage, and flew to the south and southwest with the army which came over in July.

"The first flying over came about the 21st of July, from a northeast course, and that was the time they visited our crops and made a general raid. Since that time to the first of September, they have been flying more or less, but have done no great harm.

August 6.—"They passed over in large swarms to the southeast. These did us little harm. They have laid eggs to a limited extent in our county."—M. D. L. Pettigrew.

It will be seen from this that swarms from some source or other began to cross the state line to the eastward on July 8th, at Pembina, and that, as a general rule, the date of arrival of large swarms becomes later in the season the farther southward the point of arrival moves. And all these are only the incomings of swarms noticed at prominent points on the border; how many more have crossed or recrossed at other places where there was no one to report their comings, can only be guessed at from the immense clouds that have rolled over the state, passing and repassing each other to the south and east, from the 20th of July to the first week of September. At least one large swarm, in addition to those already recorded, must have entered somewhere to the northwest of Douglas county, shortly before the 18th of August. But whatever form or continuity these bodies may have had before

reaching the state, it was soon lost after their arrival. It is not easy to trace them, even from one county to another, as they passed over ground already occupied by earlier comers. All we can say is, that there were extensive movements in certain directions, on certain days.

MOVEMENT OF SWARMS WITHIN THE STATE.

The movement of the various swarms of our own hatching early in the season has been already given. By the 10th of July the counties to the south of the Minnesota river were generally free from locust, and had begun to congratulate themselves on their delivery. Between the 10th and the 20th the locusts had begun to increase largely in numbers in the northern counties, but the fact that additions had already begun from abroad was not generally known. The greater portion of these had begun to move southward by the latter date and passed various points between Lac qui Parle and Madelia on or soon after July 20th. They passed gradually along over the counties that had been injured during the spring by our own stock of locusts, and by the first of August had reached the southern line of the state and many had passed on into Iowa. As they moved along, portions remained behind here and there, but there was no extensive deposit of eggs until they reached the southern half of the lower range of counties in the state. It seems probable that these bodies also brought with them to the southward, parts of our own hatching swarms that had flown northward early in the month. But by the twentieth of the month the locusts had mostly disappeared from along the lines of the Saint Paul and Pacific, and the Saint Paul and Sioux City Railroads, and there were congratulations once more that "the hoppers were gone." A line showing the eastern limit of their raids at this date would pass, generally speaking, along the eastern boundary of Todd county, through Stearns, Meeker, the eastern part of McLeod, through Sibley, Nicollet, and the northwest corner of Blue Earth, and in Martin county as far east as Faribault.

Between the end of July and the sixth of August, new swarms had been collecting in Otter Tail, Grant, Stevens, and Big Stone counties, and in some of the eastern counties of Dakota; and on the latter date, a wind from the northwest gave these an opportunity they had apparently been waiting for, and there was a general flying to the east and southeast, over a large portion of the western half of the state. In the southwestern counties,

where the new-comers could be traced directly back to Dakota, there was very little alighting, and the swarms mostly passed over into northwestern Iowa. By this raid of the sixth of August, the area of visitation was extended eastward to St. Cloud, into Wright and Le Sueur counties, and across Blue Earth and Martin counties. After the sixth of August, clear weather and favorable winds, at various dates, carried the line still further eastward, as on the eleventh, the fourteenth, and especially on the eighteenth of August, when large swarms flew over Elk River, Monticello, Glencoe, Shakopee, Blakeley, Belle Plaine, Le Sueur, Mankato, and Blue Earth City, and one flight was seen as far east as Hastings. During the week ending August 26th, they were seen flying over or alighting at various times in Rice, Waseca, Steele, Faribault and Freeborn counties, and are said to have appeared over Rochester. By the first of September they had added Waseca, Freeborn, Carver, and portions of Hennepin, Sherburne, and Benton counties to the "grasshopper regions," and some slight additions to the eastward have been made since the latter date.

The comparatively slow rate of progress to the eastward through the season is surprising, considering the long distances which the locust is supposed to travel, and the impression which one receives from seeing a swarm passing in one direction through an entire day. It is easy to imagine that such flights must have come immediately from British America or Montana, and that they will shortly reach Wisconsin and Illinois. But the locust, as it appears in our state, moves (with perhaps rare exceptions,) by day only and often for only a few hours in the day, and a halt for the night is easily prolonged by head winds or cloudy weather into a halt for several days; nor do the swarms move continually eastward, although the line of encroachment is continually moving in that direction. In one case at least, a body that had moved easterly over a county on the 24th of August, returned directly west one week later. (Freeborn County Standard, editorial, Aug. 31, 1876.) There is no knowledge that any swarm has (in Minnesota) reached the Mississippi river south of Hastings.

But the general direction of movement since the twentieth of July has been to the southward and eastward. The experience of the summer has shown that the Big Woods offer no impassible barrier. Hitherto, the incoming swarms have reached about as far east (but not in great numbers) as Lake Washington, in Le Sueur county, longitude $16^{\circ} 15'$ (nearly) west. They have reached this point toward the end of August, when impaired in strength and activity. But the invasion of the past summer has been

characterized by the incoming of fresh and still active swarms late in August, and these have been carried by winds blowing freshly from the west, as far east as Mower county, longitude 16° west. It may be proved in future that the eastern limit of invasion is determined solely by the extent to which winds prevail from the west, together with the length of the season during which the locust retains its full activity and strength. The connection between the movements of the locust and the prevailing direction of the winds, seems likely to receive more attention than has hitherto been paid to it. While the timbered country of the northeastern part of the State has been but little infested, to any great distance east of the Mississippi, it may be said that that portion of the state does not lie in the direct line of invasions. There is nothing to show that swarms purposely turn aside from the heavily timbered regions and go elsewhere, although in partially timbered sections they alight mostly in the open farms. But, having once entered the timber, their progress is soon ended, and no more fortunate destination could be selected for our departing swarms than Northeastern Minnesota. Locusts have been quite numerous about Brainerd throughout the summer, since early in July, and their numbers were perceptibly increased on the sixth of August, apparently brought in by a strong wind from the southwest; but these evidently found their progress impeded by the timber, for they did not extend to any distance east of Brainerd, along the Northern Pacific Railroad, nor did they lay eggs to any extent about Brainerd.

The connection between flying movements and the direction of the winds may be shown by the following diary kept by Lieut. R. B. Plotts, of Elk township, Nobles county:

July 5.—“Light wind; first flight came from the northeast, and commenced to settle down about 10 A. M.; attacked gardens first of all. They remained here till Sunday, the 9th, when in a brisk breeze from north-north-west, a light rain the night before, they flew from early in the morning till after sundown, and lit heavily south of me.

July 10.—“Wind southeast; flew heavily to the west, the highest appearing to sheer off southwest. Got a heavy light from those east of me.

July 13.—“Late in the afternoon wind suddenly veered to northeast, and they started immediately. Nearly all left me.

July 15.—“Wind north, veering to the east. Not a very heavy flight to the west.

July 16.—“Wind south-southeast. Still going west.

July 17.—“Wind east, trending north, showery. Before the showers commenced, could be seen going west. That ended the first raid. No more flying over till

July 20.—“Second raid came in on a west-northwest wind, and lit at night.

July 22.—“Wind north-northeast, heavy flight, and coming down all day.

July 23.—“Wind northeast, haling east. Heavy flight; came down heavily, and covered everything nearly.

July 24.—“Wind varying from north-northeast to east. Coming and going all day; some commenced laying eggs, which was kept up till this raid all left us.

July 27.—“Wind from north and east. Heavy flight, and most of them left here.

July 29.—“An east wind took all this raid away, the upper current being to the southwest. No more flights until

Aug. 6.—“Light wind from northwest. Another heavy raid came in. These remained till

Aug. 10.—“when wind again came from the northwest, and it rained. As soon as the shower was over and before the sun shone out, the hoppers started in heavy flight.

Aug. 12.—“The red mites were first noticed doing much damage to the eggs.

Aug. 13.—“Another showery day, and immediately after the rain they started south.

Aug. 14.—“Wind from north and north-northeast. They started early and before the sun came out, although it was quite cool; about all of this raid left.

Aug. 16.—“Very cloudy, with variable winds. Suddenly, while it was quite dark with clouds, the hoppers jumped up and flew off southwest; the very first puff of wind from the northeast, and they all left here.

Aug. 18.—“Wind again from the north. A very heavy flight passed over, high up in the air. None alighted. Red mites disappearing.

Aug. 23.—“Wind hauling to westward, and some few stragglers flew as near south as they could.

Aug. 24.—“Wind northwest. Grasshoppers very high and heavy flight to the southwest.

Aug. 25.—“Wind northwest. Heavy flight to the southwest, very high.

Aug. 31.—“Showery for several days before; wind suddenly north-northwest, and by 10 A. M. many grasshoppers were flying. By noon, in the upper air and almost indistinguishable, was a heavy body going southwest. None lit here.

“On the dates intermediate between those given the wind was very light, and there were no flights, except perhaps short ones, from one part of a field to another.

“When the directions of flight are not expressly stated, they correspond almost exactly with the direction of the wind.”

AREA OF THE PRESENT DEPOSIT OF EGGS.

A line showing the eastern limit of the area where eggs are now deposited in Minnesota would include (very nearly) the western tier of towns in Mower county, the western part of Steele, Rice, and Scott counties, the whole of Carver, the western part of Hennepin, along the river (in Sherburne and Benton counties, and in many places thickly in the timber farms,) the southern part of Todd county, then westerly including Otter Tail, the southwestern part of Becker, and portions of Clay counties. To the south and west of this line the locusts have had possession of more or less of the state from the fourth of July to the first of October, and it would be difficult to specify with any exactness especially in the eastern part of this area, where eggs are most or least thickly laid. But the counties along the Red river from Glyndon to Lac qui Parle are comparatively free from eggs, unless in the eastern portions, and again many towns from Madelia westward in Watonwan, Cottonwood, Murray, Redwood, and the whole of Lyon and Lincoln counties are almost entirely free from eggs.

The accompanying map will show the area of eggs deposits for the last four summers, but the lines must not be construed too exactly. They are intended to cover generally the outside limits. As for the limits of the deposit during the present year, it is impossible to draw it exactly, and no doubt a few locusts will be found hatching in many spots next spring which lie to the east of this line. Late in the season, considerable numbers passed over Owatonna to the eastward, some over Mantorville, and possibly a few over Rochester, and these, perhaps, will be found to have alighted and laid eggs somewhere in the southeastern counties. On our borders eggs are laid in the southwestern counties of Dakota as far north as Rock Co., Minnesota, and in Iowa as far east as Mower county.

PLACES WHERE EGGS ARE DEPOSITED.

These eggs have been deposited, as a general rule, in the vicinity of cultivated fields, and in each township the extent of the deposit is measured, in some degree, by the amount of land under cultivation. It is not presumable, at least, that wild prairies or lands lying far distant from tilled fields, are extensively filled with eggs. The locust is attracted and held by the growing crops, and it seems to be something more than a mere coincidence that the area devastated by the young in the spring does not become a laying-

ground in the summer ; this is especially true of the present year, and the same strip of country where the locusts hatched in the spring, and where the little that was planted, was mostly consumed by them, is at present exactly that portion of the infested area that is now most nearly free of eggs, although the deposit is abundant enough in the counties to the north and south of it. Nor do the prairies, when covered with grass, present many favorable situations for the deposit of eggs. The experience of the summer would seem to show that almost any bare, sunny spot, where the earth is hard enough or moist enough to retain the shape of a hole, is selected by the locust when she is ready to lay. To what extent the prairies in general are filled with eggs, cannot be told, of course, until the time of hatching arrives, but in the vicinity of cultivated fields the wild prairie has received its share of eggs. Throughout the whole area already given, with the exceptions named, there is hardly a town where the deposit was not so extensive by the first of October as to form one of the most serious of all considerations for next year's crop. These eggs are laid sometimes in ground so hard as to resist the point of a knife-blade, sometimes in sand-heaps so soft that the next shower washes off the sand and leaves the egg-cones standing like pegs in the ground ; on knolls high and clear of all moisture, on sand-bars in the rivers, and in flats so low as to be overflowed by the next rain. But the most favorable spot of all, everywhere, is new breaking. Grain fields have generally suffered most damage on the sides nearest to new breaking, and, conversely, in new breaking more eggs are laid on the sides nearest to grain fields. In some counties, a large amount of new breaking has been done by non-residents, and will furnish a fruitful source of evil next spring. Of circulars sent to nearly all the infested towns to ascertain the extent to which eggs were deposited during the season, the following, from Blue Earth county, is a sample of all, as to the extent of the deposits, and the spots where they are situated :

Beauford.—“ All over the town ; not much in the stubble, but on all bare spots, such as sheep-pastures, between the rows of corn and potatoes, gardens, all places that were clean of weeds, river bottoms, where fed close, timothy stubble and road sides.”—J. S. Larkin.

Butternut Valley.—“ It would be difficult to run down a spade and turn the dirt anywhere in stubble, corn, potato fields, meadow, or road, without finding eggs. It seems as twenty to one before, and they destroyed everything.”—Samuel D. Shaw.

Ceresco.—“ Over the whole township, very thick in most places.”—J. M. Mead.

Jamestown.—“They have deposited their eggs on nearly every farm in this township.”—A. P. Davis.

Judson.—“They have laid eggs very extensively, especially on new breaking and roads, some in the stubble, grass, prairie and corn lands.”—Humphrey H. Jones.

Leray.—“Eggs are laid on every clear, dry place in the town; mostly in corn fields, potato fields, gardens, and in the highway.”—Ira B. Reynolds.

Lime.—“In the flats along the Minnesota river they are thicker than in the timber, but along the roads, and in old pastures, they are so thick that nobody can have an idea, unless he has seen it himself.”—Jacob Born.

Mapleton.—“There is not a farmer but claims that every favorable spot on his farm is thoroughly peppered.”—J. E. Brown.

Medo.—“All timothy pastures, all new breaking, in the roads, and in some stubble to a limited extent—from 6 to 10 acres in each quarter.”—B. F. Steadman.

Rapidan.—“Every favorable place is well filled; roadsides, tame pastures, and new breaking thickest, corn fields next, and stubble fields and unbroken prairie least.”—James B. Swan.

Shelby.—“All along the highways and especially on all new breaking and old pastures, corn fields and prairie lands that are eaten out by pasturage, and in fact there is no such thing as exception from them.”—Thomas J. Cross.

South Bend.—“Eggs are deposited in every rood of dry ground in the township.”—D. P. Davis.

Sterling.—“In some places the eggs are stuck in very thick, but in the fields generally the eggs cannot be very thick. Still, in the aggregate there are very many, being everywhere, even in the timber.”—N. A. Hunt.

Vernon Center.—“Eggs are deposited all over the township, and in some places very thick, seemingly no room for more, and in other places (wheat stubble,) not so many.”—E. W. Washburn.

The laying this year seems to surpass that of former years not only in the area filled, but in the numbers deposited everywhere. This could hardly fail to be the case when the laying commenced early in July and was prolonged into September, and when some towns received deposits from two, three, or even four different bodies. Where new breaking was harrowed in the fall the eggs often appeared strewn on the surface as thickly as grain is sown; e. g. “I have just dragged a new piece of breaking, and the eggs were as thick as wheat sown at the rate of one and a half bushels per acre; but I think they are thicker on breaking than anywhere else. (S. S. Clevenger, town clerk of Bismarek, Sibley Co.)

TIME OF DEPOSITING EGGS.

The time when eggs have been deposited this year has been stated already. The time when, or rather the age at which the

Rocky Mountain Locust deposits its eggs, is a different question. The same species has laid eggs in Kansas, this year, as late as the 13th of November, and may continue to lay in Texas as late as the first of December. (Riley's 7th Ann. Report, p. 192.) If the mission of the locust is to lay eggs once and die, what could be the time or place of birth of those insects which have apparently first reached maturity by the first of December? Although it has been considered possible that these are a second brood whose parents were hatched in the preceding April or May in Texas or Colorado, there is no knowledge of the time or place of any such second hatching. If these late laying swarms are such as those which come down from the Snowy Range in Colorado, in the latter part of August (vide N. C. Meeker, quoted in Riley's 8th Ann. Report, p. 84) it must be admitted that the mountain-born broods are a longer-lived and more vigorous race than any bred in Minnesota. Besides this, among the swarms which have come in upon us this year, many were found dying as late as October, containing eggs. That the Rocky Mountain Locust lays eggs twice or three times in a lifetime, has been the result of some guess-work among our farmers, who considered it necessary in order to account for facts as they saw them. I give the result of a single experiment.

On the 25th of June, I shut up in wire gauze cages nine pupæ of the Rocky Mountain Locust. The bottoms of the cages were filled with earth packed hard, and the insects appeared to thrive in confinement. By the second of July they had all become perfect insects. By the 8th of July they commenced coupling, and were seen repeating the act for several days. On the 15th and 16th two of the females went through the form of depositing eggs, and I marked the place of deposit on the edge of the cage. The coupling was repeated again as before, until the third of August. At that date the coupling ended, and the locusts became almost inactive, and were seen to eat very rarely afterward.*

On the 14th of August one of the males died; the female died on the 9th of September, and was found to contain fourteen full sized eggs, but I found on examining the cage that there was also

* The early part of this coupling season was one of the greatest activity on the part of these insects; they dashed themselves against the wire of their cages as though all space would be too small to contain them; there would be a flash of the wings, extended and closed again in an instant, or that movement of the hind legs known as "fiddling," which seemed to be a well known signal between the male and female. In cages, where several pairs were confined together, the male, while in the act of coupling, would repeat this movement, if brushed against by another.

a full sized egg-cone where she had already appeared to deposit on the fifteenth of July. Of the rest of the Rocky Mountain Locusts the males were caged with some female Red-Legged Locusts caught in my garden, and although the two species did not seem inclined to have much commerce with each other, I saw one pair coupling. These observations are very slight and imperfect, but are given for whatever they might be worth. That the male dies first may be inferred not only by the above experiment, but from the fact that in September it was common to find many pairs coupled, of which the female was alive, but the male had died without releasing himself.

PARASITES AND ENEMIES.

The various insect enemies of the Rocky Mountain Locust have been described sufficiently for common information by Prof. Riley on pp. 44-46 of the "Report of the Proceedings of a Conference of the Governors of several Western States and Territories, at Omaha, Nebraska, in October, to consider the Locust Problem." As the descriptions are further illustrated by plates, and as the pamphlet is intended for public distribution it may serve to prevent some of the confused knowledge about these parasites and enemies which has heretofore prevailed to a considerable extent. The amount of help which may be expected, or has already been received, from these enemies of the locust is, in *limited areas*, even greater than Prof. Riley would assign to them. These are farms where in loose, mellow soil it is now almost impossible to find eggs, yet but a short distance away eggs may be found in abundance in hard ground. There was also great difference in the different flying swarms in regard to the presence of the internal grub. While in some places hardly a locust (one out of five,) could be found that was not affected by some internal parasite, in others they were almost entirely free from them. Mr. W. C. Ralls, of Le Sueur, examined 624 locusts between the 7th and 10th of September, and in 9 of these the grub was found, and in 10 the hair-worm. It would be well if we could add to this help which is given without expectation of bounty or relief, the help which might have been added by thousands of prairie-chickens killed during the fall. When a whole community stands in need of every form of assistance that man and nature can render, it is worse than useless to throw away the help, however slight, that any willing instrument is ready to contribute.

DAMAGE TO CROPS.

The form and substance which this report might have been expected to assume early in the season, have changed considerably under changing circumstances. The various means of contending with the locust have been set forth generally and in detail during the past four months; and the amount of damage which has been inflicted upon the crops, while it might have been ascertained with some precision in five or six counties, has become a different matter when combined with severe losses by drouth, and extending over thirty-five or more counties. The exact amount of loss in so many different counties, varying as it does from almost total loss of the grain crops to slight injury to gardens and late corn, can not be arrived at with any less efficient machinery than that of the Commissioner of Statistics, to whom the whole of this portion of the subject properly belongs.

Of grain, the oats and barley have, as usual, suffered the most; in Raymond, Stearns county, where the locusts were most numerous from the 23d of July to the 20th of August, "the Lost Nation wheat was only slightly damaged, while the Fife wheat was ruined." (So stated by L. B. Raymond, Esq.) The same fact was noted by P. Hoffman, Esq., of Westport, Pope county; but it is not known how generally the rule will apply.

Corn and potatoes have escaped with less damage everywhere, though corn attacked in the silk has been ruined. Peas are never specially mentioned except to note their escape from injury. ("On the whole, we consider peas and potatoes the best crop to raise."—S. S. Gilliam, Big Bend, Cottonwood county.) Sorghum is almost locust proof so far, both against the young and old. Flax, tobacco and beans are generally mentioned to note their almost total destruction. Farms lying on the east side of lakes have generally suffered less than others, both in this state and Dakota. In some cases farms situated in the timber have been passed over altogether; in others they have yielded 5 to 10 bushels to the acre, while crops on the prairies in the same town have been failures; on the other hand, rarely the timbered portions of a town have suffered more severely than the prairie farms.

PRACTICAL METHODS OF CONTENDING WITH THE YOUNG LOCUST.

The different means of contending with the locust both in the egg and the unfledged state, have been set forth so fully and so often within the last two years, that they ought by this time to

have reached, in some form or other, the hands of every reading man in Minnesota. The report of the commission appointed by Governor C. K. Davis in 1875, (of which some 5,000 copies were printed,) the proclamation of Governor J. S. Pillsbury, issued August 30th, 1876, containing the gist of all the known methods of locust warfare, and the many and oftentimes excellent amplifications and details of these methods, as they have appeared in the state newspapers during the summer, cover the whole ground so far as it is known. Finally the Report of the Proceedings of the Omaha Convention repeat, in twelve excellent pages, the whole subject once more, and a reprint of these in the newspapers of those counties where the evil is new and comparatively unknown, ought to leave no further lack of information.

It ought also to be understood that these sources contain all that has so far been made public on the subject, and that the farmer must for the present defend his crops by these means or not at all. We are so accustomed to the comprehensive methods of farming by machinery that it is hard for us to come down to the petty exercise of individual exertion which the European peasant would consider only a regular portion of his daily existence. But whatever may be the success of various machines and applications which are now in preparation, but not to be disclosed at present, there is as yet no labor-saving contrivance, capable of being applied over large areas, which can accomplish anything like a universal destruction of the young locust, and the general law of labor holds good, that a man's success is measured by the earnestness of his own endeavor. Even the difficulty which results from sparseness of population may be overcome in some little measure; where a few farmers in a township where eggs are laid have determined to sow a small acreage and to defend it to the best of their abilities, something may be gained by combining and sowing in partnership, or side by side, the fields that would otherwise be distributed over a township. Of course there are objections and difficulties to any such method of proceeding, but they are at least no greater than those already presented in the mere fact that the locust is present. On the other hand the advantages would be great; half a dozen families acting in concert and in the defense of one large field would accomplish far more than by any disjointed efforts; it would be far easier to defend the four sides of one large field than the twenty-four sides of half a dozen smaller ones; and lastly the single field would have a smaller number of locusts in the aggregate to contend against, and insects hatched at a distance from it might never reach it before flying;

at least it is certain that fields lying within three miles of the hatching grounds of last spring, remained untouched until the flying season.

WHAT MAY BE DONE BY ENERGY AND PERSEVERENCE.

Although it is impossible for me to add at present anything to the many and various methods of locust-warfare that have been repeated so often, it may be of some value to show what has been or may be done with those already known. It was not as a mere form of speech that the conference at Omaha concluded with these words:

“That our consultation with each other and with those who have tested the matter, has resulted in the firm conviction that by proper efforts, concerted action, and a vigorous and determined warfare against them, the young grasshoppers which may be hatched out next year; or any subsequent year, can be successfully fought and our crops saved; that we are not without remedy, but we may protect our crops against them if we will but make use of the means within our reach.”

The conditions of success here noted, “proper efforts, concerted action, and vigorous and determined warfare,” have never yet been applied in Minnesota. The truth of the above quotation, is shown by the fact that where even individuals, contending alone not only against the locusts hatched about them, but against those which the concerted action of their neighbors should have rendered harmless, have defended their crops with perseverance and determination through a whole season, they have in the end received a return which justified both their usual and their extra labor. Even the most petty means of defence, if kept up persistently through a whole spring, will often effect a saving of a considerable portion of the crop. The town of Lime, in Blue Earth county, one-half of a government town, in 1875 turned out its whole population to battle with the young locusts with brooms, switches, and every weapon they could lay hands on, and returned an average crop of 12 2-3 bushels of wheat, 36 bushels of oats, and 36 bushels of corn to the acre. The town reported no damage from locusts, and the return was about the average crop for the whole county, and a fair yield.

Charles Pelzel, of Milford, Brown county, by spreading tar over strips of building paper, and placing these along the sides of his fields, saved most of his crop, while those of his neighbors were badly damaged. The paper was re-spread with tar as often as it

became covered with young locusts. On 25 acres of wheat he saved 223 bushels, and on eight acres of oats 400 bushels. All this was at a cost of \$3 for tar.

Mr. N. V. McDowell, of Bigelow, Nobles county, who has fought the locusts persistently ever since they came in 1873, by 10 days' extra labor in hauling and burning straw, saved a fair crop on 55 out of 70 acres cultivated, but his exertions were rendered useless by the raids of July and August. Even after these he was able to harvest five bushels of wheat to the acre on early sowing.

The only crop of small grain harvested in the town of Holly, Murray county, this year, was by Mr. J. M. King. He writes:

"I put in about 50 days' labor for one man. I caught 100 bushels in my net, and destroyed as many more by scattering straw over their hatching grounds and burning them. I also put to flight swarms and droves of them after they began to fly by use of bags nailed on to from 25 to 50 feet of pole or board, with which I trailed back and forth across my fields, at times driving them like sheep, and at other times not making much impression. I saved 450 bushels of wheat from 52 acres, but firmly believe that if we had had a favorable season, the hoppers would have hurt it but little; but the dry weather, coming as it did, seemed to kill it."

The following experience is also worthy of being recorded:

Mr. S. W. Danforth, of Madelia, Watonwan county, after having once resolved (in 1874) that he would put in no crop whatever should the locusts deposit eggs on his farm a second time, resolved once more in 1876 that he would determine whether he or the locusts should be master of his farm. On the north side of his wheat field was a prairie ridge where the locusts hatched in the spring. These, while very young, began to come into the field on the north, and had reached it before being discovered. He began by burning them with straw on the edge of the field and on the adjoining prairie, constructing a ditch along the side of the field at the same time. Smaller ditches were also made inside the field to stop those which had already entered. When young, they were also delayed by simply harrowing over the soil and presenting a rough surface for them to crawl over. Seven or eight days were spent in this way, and after the ditch was finished, it turned away the locusts so completely that the work was considered done, and the crop saved. On the western edge of his field was a strip of prairie grass, 40 rods wide, and beyond this some stubble and old corn grounds, belonging to a neighbor. Here the locusts hatched out abundantly. About a week after work was done on the north side of the field, these had crossed the strip of prairie and entered the field from the west before being noticed. As soon as they were discovered, he got all the help he could and made a ditch as fast as possible. This stopped them for nearly a week, and then they began to cross it. He hitched a horse to a plank and walked him up

and down in the ditch, and this turned them aside for a while. There was a cloudy day on which the locusts rested, but when the sun came out they were ravenous, and there was no stopping them. They crossed the ditch, and filled the straw-fire so full as to extinguish it. He called in his neighbors to see what would happen to them if the locusts were allowed to keep on in their course, and five or six turned out with teams, hauling straw. With this they burned over a strip three or four rods wide and a hundred rods long, along the edge of the field. But in spite of all his efforts, the locusts had made their way into his wheat, and by this time he had finished a catching-net. The next day, in five hours, he caught from 15 to 20 bushels. This was continued daily, until 75 or 80 bushels had been caught, and it was not necessary to use it, except as occasion demanded on certain days, or in certain spots where the locusts were thickest. This work was so effectual that there should have been (except for drouth) a fair crop of wheat, or at least half a crop all over the farm, except where the burning was done. This demonstrates the possibility of one farmer's fighting two farmers' locusts, and still saving half a crop."

CATCHING-MACHINES.

Many other isolated cases of persistent and partially successful efforts in saving crops from the young locusts have occurred this year; I mention these because they have been reported more fully than others. It also shows what can be done with machines in the later part of the season, and what might have been done by attacking the locusts in their hatching-grounds instead of waiting for them to approach the grain. The coming spring seems likely to test what can be done with catching-machines. Not only are several elaborate ones patented or prepared for use when the time comes, but many farmers are already preparing such machines after their own fashions. To those who are deterred by cost or by lack of a model, it should be said that an efficient machine can be made at a cost of a few poles or strips of board, a pair of wheels, a few yards of stout canvas, and just sufficient ingenuity to construct a long, open-mouthed bag to run over the fields with its lower edge near the ground, and running back in the rear to a sack to contain the locusts that are caught. Mr. King's net was such, and captured from two to eighteen bushels per day, depending on the size and age of the locusts.

Mr. Danforth's machine consisted of two wheels, connected by an axle 20 feet long and six inches in diameter; this was made of a stout pole obtained from the woods, and it was necessary that it should be so large and strong, for the loads of young locusts captured were sometimes so heavy as to bend even this badly. Across the top of this axle two poles, of about the same diameter as the

axle, were fastened, running back nearly to a V some eight or ten feet behind the middle of the axle, and extending forward and opening out in front of it. The front ends of this V was steadied by a cross-piece. This was the frame-work. The net was made of about 40 yards of cotton cloth, cone-shaped, in front about 18 feet wide, from one side to another along the axle, and six or eight feet high from the ground to the top of the net. This net narrowed back about seven feet until it was some five or six feet in diameter, and terminated in a stout canvas bag three or four feet long, closed with a string at the rear end. The heavy loads of locusts caught (sometimes 500 pounds) made it necessary to have a support for the net and bag, and for this purpose a triangular floor work of boards was made, the front end supported from the axle, and the hind end from the hind end of the V poles, and running as near the ground as possible. The lower edge of the net in front was kept close to the ground by a piece of light scantling fastened to the edge of the cloth, and rising and falling over uneven surfaces. The horses were hitched to the ends of the axles, outside of the wheels, their breasts extending forward nearly to the front ends of the V poles, where they were fastened by the head. The net sloped backward at the top in front, and when the machine was in motion a man stationed on the axle with a broom gave the locusts as they entered the net a start toward the rear end. Just where the cone terminated in the oblong bag, a large piece of canvas had been cut out and wire gauze inserted, and the locusts moved towards this on getting into the net, attracted by the light. The only outlay in constructing this machine was for the 40 yards of cotton cloth. This net captured from eight to twelve bushels of pupæ per day when first used, and the amount diminished daily till the 24th of June, when about two bushels were taken.

Mr. Andrew Webster, of Norseland, Nicollet county, had, in 1875, about 230 acres of wheat sown. The locusts began to hatch about May 17th, and he commenced at once to destroy them by burning with straw. As it was impossible to protect the whole of his crop with the help at hand, he selected a field of fifty acres to defend, and burned all the locusts that hatched near it. This continued until June 11th, when the straw was exhausted, and the locusts had begun to come in from the adjoining fields. Two catching-nets were then rigged up, (of the usual form,) attached to axles fourteen and sixteen feet long, each drawn by one horse moving at a fast trot. The amounts caught were: From June 11th to 17th, (part of the time with one net,) 121 bushels; with both nets, June 17th, 37 bushels; June 19th, 20 bushels; June

21st, 77 bushels ; June 22d, 63 bushels : June 23d, 45 bushels : June 24th, 71 bushels ; June 26th to 28th, 128 bushels ; June 29th, 59 bushels ; June 30th, 28 bushels ; July 1st, 18 bushels, when the work was discontinued, as the locusts had begun to fly, and had become too scattered to be caught easily. The catching was done along the edge of the field, and between the hours of five and ten p. m. It required the labor of four men and four horses during these hours. The whole number of bushels caught was 667, and, on threshing, 658 bushels of wheat were harvested from the fifty acres.

DITCHING.

The experience of Minnesota in regard to ditching, in 1875, was so successful, and so strongly and fully confirmed by the testimony of reliable men, that the experiment should have seemed worthy of a more extended trial than it has received this year. But few ditches have been dug, but these, even when left to take care of themselves, have generally served as a barrier during the earlier half of the season. A ditch, to be effectual, needs care and watching ; when its sides have been washed down by repeated rains, and it becomes a mere curved surface, it is a very slight barrier indeed. The time and trouble of constructing such ditches as these, would be spent better otherwise.

CONTENDING WITH WINGED LOCUSTS.

Here and there during the past season have been cases of one farmer or a few farmers in a township who were able to save some portion of their crops from the flying swarms. The number of cases where this has happened is in some twenty-five or thirty out of the whole number of towns in the state that have been invaded. When there has been any success at all it has generally been early in the season, and over small patches of garden or cornfields. There are towns where farmers have smudged, roped, discharged fire-arms, and rattled tin pans, until straw stacks and patience were exhausted ; and all to no avail. Others have worked hard smoking and roping their fields, supposing all the while that they were accomplishing something, only to find in the end that they were worse off than neighbors who had done nothing. Others, who have had plenty of straw at hand, have, by firing it at just the right moment, managed to save a field. But the uselessness

of all such attempts has generally been too apparent to encourage any hope of even a chance of success.

BURNING PRAIRIES.

The amount of help which may be received from burning the grass on the prairie at the time of hatching, seems likely to be well tested next year, as the efforts to preserve the grass have so far been generally successful. The exact amount of help that can be derived from a general burning must vary much, with differing circumstances, from one year to another, and the opinions as to its value differ greatly. To those who believe that the whole region of uncultivated prairie in the western part of the state is extensively dotted with eggs, nothing could seem more important than a general preservation of the grass, difficult or impossible as this may be. There is no question whatever as to the value of preserving it in all cultivated neighborhoods, or in all regions that are interspersed with farms. And yet even in these it is difficult to select a time for burning which will not allow the escape of some portions of those already hatched or of those still unhatched. But even if the help falls a great deal short of general destruction it is still a help; even if no insects are hatched on the prairie they often hop away in large numbers while going off the bare fields into the prairie grass, and may be destroyed in large quantities. In addition to this, where the grass is burned late in the spring it gives place to a growth of young and tender grass which often serves to entice the locusts away from the crops. In Watonwan county last year only about one half of the grass was saved through to May or June, in Cottonwood county less than one half, in Redwood, Murray and Lyon counties, hardly any. Wherever it was fairly tried in Cottonwood county, those who had charge of attending to the preservation and firing of it are strongly convinced that efficient service was rendered by it.

PLOUGHING AND HARROWING.

The prevention of the eggs from hatching by deep plowing or by surface harrowing has been urged in the Report of the Omaha Conference, and none too strongly. While there is much difference of opinion in regard to deep plowing, there is strong testimony to show that where the eggs are turned under to the depth of ten inches they either never hatch at all, or come forth so late as to be incapable of harm, appearing sometimes after the corn

has reached the height of three or four feet, sometimes as late as the end of August. But if there is any point in the whole subject where opinions seem to be unanimous, it is in regard to the value of harrowing up the eggs in the fall, and exposing them to the influence of weather, birds and other enemies. In this connection the general harrowing of new breaking and plowing of roadsides that has been done by many farmers, or by townships, cannot fail to be of benefit. That this work should commence in our climate as soon in the fall as there is any assurance that the egg-deposit is ended, is evident from the consideration that the longer the egg is exposed to the above mentioned influences the more sure its destruction is likely to become, and from the fact that in many places the ground became frozen before the work of harrowing was nearly finished.

THE NEED BOTH OF STATE AND OF INDIVIDUAL EXERTION.

It will be fortunate if science and national discovery shall finally be able to dispel for us some of the uncertainties which beset the locust problem in general. It is the doubt in regard to the future and the fear that each year may prove more disastrous than its predecessor, that give the evil more than its real magnitude and paralyze hands that are not otherwise accustomed to refuse labor. To simplify the conditions of the problem as far as possible, to determine how far the goings and comings of a fitful insect hurrying destructively over thousands of miles of grain fields, and sowing everywhere the seeds of future devastation, may be foreseen or prevented, is an object worthy of the highest science and the most liberal enterprise. But the help that can come from any such source must necessarily be long in action and slow in results. With all our uncertainties, we have one certainty before us in the immediate future; it is that of a great and wide spread injury which only prompt, efficient, concerted and continued effort can remedy. We cannot offer to do less than to render at once by ourselves and to ourselves a portion of that help which we ask a broader knowledge and enlarged means to render unnecessary in the future. The state of Minnesota has already taken the lead in the proposal of a conference upon the locust subject, which, if the results compared in any fair measure to the objects proposed, will end in more definite knowledge and more efficient action throughout all the region that has been overrun for so many years. The state may fitly supplement the action of the conference by determining once for all just what can be done with the

evil when it has taken root here. It is no longer a question that that is a state matter which concerns more or less intimately forty-four out of seventy-one counties.

But the matter does not end with the state. After all that can be done by legislation, success depends purely upon how much each man is willing to do with his own hands. Without united effort to meet the evil wherever it occurs, and with every means or instrument that lie at our disposal, without a determination to plow and sow and defend, each and every man on his own domain, nothing will be done that is worth legislating about. No effort is worth securing that does not recognize the need of the broadest possible exertion, or offer the largest possible assurance of ultimate success.

BOUNTY.

The conference at Omaha, while recognizing the necessity for united action, both of the state and of every individual throughout the present infested regions, resolved "That it will be wise and politic for the legislatures of each of the states and territories most deeply interested in the locust question, to enact a state bounty law," etc. As there is in the minds of many a grave doubt as to the expediency of offering any bounty at all which shall take the form of a specified amount to be paid per bushel for locusts, and as it will be difficult to enact any law which shall be equally adapted to the thickly settled counties and the thinly settled frontier, I have included in circulars to the different towns the question, "If a bounty were offered in your township, next spring, for the destruction of locusts, could it be made to any extent successful in saving crops?" and "How small a price per bushel would accomplish the purpose?" The farmers ought to know at least as well as any one the capabilities of their own communities, and it is some proof of the sincerity with which they have made their replies, that in counties where the locust is comparatively unknown, it is answered that they are unable to give an opinion; in the sparsely settled counties, the doubt is often strongly expressed that such a bounty would be useless for the purpose stated; while in those counties where the locusts have hatched of late years or where the bounty system has already been applied, it is considered that a bounty per bushel would undoubtedly accomplish the object named. The amount is generally placed at one dollar per bushel, seldom more, and often one-third or one-fourth of that amount; and while one dollar per bushel might be

none too great a price per bushel for locusts immediately after hatching, it is certain that in a very few days a much smaller amount would more than equal it.

By referring to the experience of Mr. Andrew Webster, already given, it will be seen that from the 11th of June to the first of July, even ten cents per bushel would have been a paying bounty, when added to the crop that was saved by the exertions made in catching. With the improved machines and contrivances for capturing that are being brought forward at this date (Jan. 30, 1877) it is certain that the state need not offer a larger bounty, at the utmost, than ten cents per bushel after the tenth of June. If the locusts exist in sufficient numbers to do great injury after that date, a few cents per bushel added by counties, or by towns, to the amount given above, will make a bounty that will amply repay labor, to say nothing of the saving in crops. It would be also an improvement, both in convenience and exactness, if a bounty were offered per pound, instead of per bushel. It is no pleasant matter to measure a few bushels of locusts that have been standing for a day or two under a hot June sun, and the hurry of an unpleasant task may be a cause of inaccuracy in measurement; but the measure in pounds of almost any quantity of dead locusts can be obtained at once, with ease and accuracy.

CONCLUSION.

In conclusion it remains to thank the many persons, both known and unknown to me, who have so kindly replied to my circulars and letters of inquiry during the season. The writers are so many that it is impossible to name them, but they have helped greatly to give this report whatever value it may have. This value must necessarily appear different to different readers; many will miss what they expected to find, or find what may appear of comparative little value. But I have endeavored to compile from all available sources what might be of benefit to our citizens and at the same time worthy of appearance in a report upon the Natural History of the State; I have tried to show not only the requirements of the present year in meeting the locust evil as we find it upon us now, but also the connection between one year and another. But whatever the value of the report may be, the State should provide fitting means for the continuance of similar (or better) efforts during the year 1877. Not only is an enterprise of this sort, if properly conducted, always a worthy one in any State which labors under an evil of such magnitude, but the help

which a national commission may derive from assistants acting under its direction in every one of the States now infested may be of great value, and will serve to bring completeness to a task which any commission will find too widely extended to reach with personal observation. There is no need to regret the trifling sums which have so far been expended upon "grasshopper investigations," nor to begrudge the few hundred dollars that will enable us to do what little we can in aid of that scientific inquiry for which we now ask of the National Government competent maintenance and the best learning that America can supply.

Respectfully submitted.

ALLEN WHITMAN.



Minneapolis in Perspective

EXTRACTS

FROM REPORTS OF J. B. PHILLIPS, COMMISSIONER OF
STATISTICS, MINNESOTA.

THE ROCKY MOUNTAIN LOCUST.

CALOPTENUS SPRETUS.

For no part of the duties pertaining to this office have I felt less favorably inclined than that of collecting and recording the statistics of the damages inflicted by this insect. To make record of dead losses such as these, out of which no possible compensating good can arise, is necessarily an ungrateful task. Were it not that danger still impends, there would be no need of any discussion here, further than by giving a bare record of the facts. But it is now patent to all, except to the willfully blind, that we have an enemy confronting us whose magnitude is not to be despised; one who is likely to dispute our right to the undisturbed possession of the country between our western borders and the Rocky Mountains, with more or less persistence for some years to come. This is the fourth year since their irruption upon us in 1873, and every year since then the damage has been serious; but the greatest danger to be apprehended is the moral effect of discouragement upon the people.

The immense losses inflicted upon so many States, the damage to the national property by the impairment of the value of the public lands, retarding their occupation and settlement, are matters of immediate and pressing importance, and call for the most serious consideration. It is the part of wisdom, without further delay, to look the matter squarely in the face, and by the most searching scrutiny, endeavor to find out and bring together all the facts bearing upon it, in order that a remedy may be intelligently sought for and effectively applied.

So far as my knowledge extends, neither in this country or in any other part of the world has any such thorough and systematic course of investigation been instituted. This assertion I am confident will be by none more heartily assented to than by those who have recently contributed most to our present stock of knowledge on the subject. After long and tedious searchings of what has

been recorded of these plagues, it is astonishing how little really reliable knowledge can be acquired.

Whether it be that because in most civilized countries the evil has generally been transient, with sufficient interspaces of time between the inflictions to allay anxiety, or whether their overwhelming magnitude paralyzed for a time the energies of their victims, cannot now be known: but certain it is that concentration and alertness of intelligence, the rigorous methods by which science in later time has penetrated the secrets of nature, has until recently been almost wholly wanting.

As a consequence, the history of the locust in times past appears to have been addressed to the imagination rather than to the understandings of men; abounding in marvelous narrative designed rather to inspire wonder than to convey valuable information.

We read how their invading armies have overshadowed the land and darkened the sun at noonday; how famine and pestilence followed in their rear, and much of like terror. It is scarcely necessary for a Minnesotian to consult the prophet Joel, or Exodus, or the high wrought imagery of the oriental writers, to acquire a realizing sense of what a locust invasion is. A visit to the western part of this State, during the past summer, would have been the better plan.

Not, then, with any purpose of regaling the reader with mentally-debauching marvels, but to get at the when, where and how he has visited and afflicted other countries, I propose to make a short and necessarily imperfect study of his past doings in the Eastern Hemisphere of the world, as perchance his haunt and habits there may throw some light on questions now up for solution by us.

The wide area over which locusts have been diffused at various periods and in all quarters of the globe, is a very remarkable fact, and one, perhaps, not generally known. In the United States, it might be said that their existence, as a serious evil, was practically unknown until we began our explorations and settlements on the Pacific coast. But, by closer examination, we find that at one time or another, they have overspread all the western portion of North America, from the British Possessions to the Isthmus of Panama. A catalogue of the places they have ravaged would include the names of every state and territory west of the Mississippi river, the western half of Mexico, and all the states of Central America. In the continent of South America, the situation has been substantially the same.

Africa, from time immemorial, seems to have been a peculiar and

favorite home of the locusts. Within its compass, and in its tropical heat, are found the exact conditions in which it best thrives.

From year to year, and from age to age, her mountain ranges and bordering deserts have been the perpetually procreant hatching-beds of hungry hosts, that have not only ravaged her own borders, but some of the fairest portions of southern Europe and the neighboring islands of the sea. For here, if many writers are to be credited, were engendered the parent stock that colonized Portugal, Estremadura, Andalusia, Murcia, Valencia and Catalonia in Spain, Provence and Languedoc in France, the kingdom of the Two Sicilies, and the valleys of the Po in Italy.

If we are to believe the reports of seamen, they have been seen 300 or 400 miles out at sea off Cape Blanco, and one instance is recorded of their having been seen 300 leagues to the windward of Barbadoes, which would be more than 2,000 miles from Africa, and 900 miles from the West India Islands.

I must confess to serious doubts as to the authenticity of this last statement, which doubt is not allayed by another story, told by the same narrator (Sir Hans Sloane), which I give as a curiosity:

"In 1649," he says; "the locust destroyed all the products of the island of Teneriffe. They came from the coast of Barbary, the wind being a Levant thence. They flew as far as they could, then one alighted in the sea and another on it, so that one after another made a heap as big as the greatest ship above water, and were esteemed almost as many under as those above the water. Next day, after the sun's refreshing them, they took flight again and came in clouds to the island, whence the inhabitants had perceived them in the air." He says they gather together 7,000 or 8,000 soldiers to fight them: "then the ecclesiastics took them in hand by penances, etc. But all would not do; the locusts stayed their four months. The cattle eat them and died; so did several men, and others stuck out in blotches. The other Canary islands were so troubled, also, that they were forced to bury their provisions. They were troubled forty years before with the like calamity."

I find a more credible account in an extract from a letter of the mate of the brig *Levant*, of Boston, who writes: "That, after having encountered a severe gale on the 13th of September, 1839, in lat. 18° north, and the nearest land being 450 miles, they were surrounded for two days by large swarms of locusts of a large size, and in the afternoon of the second day the sky was completely black with them. They covered every part of the brig imme-

diately, sails, rigging, cabin, &c. It is a little singular how they could have supported themselves in the air so long, as there was no land to the northwest for several thousand miles."

But notwithstanding these and numerous other seemingly authentic reports; so uncertain is almost every point connected with this subject that even yet it is a matter of doubt with some whether they are capable of any such extended flights, either by sea or land.

According to some accounts, these African locusts were desirous of being on sociable terms with all surrounding countries. During four successive years, from 1744 to 1747, they ravaged the southern portion of Spain and Portugal.

Pliny say that: "Many a time have the locusts been known to take their flight out of Africa and with whole armies to infest Italy. Many a time have the people of Rome, fearing a great famine and scarcity, been forced to have recourse to the Sibyl's books for remedies, to avert the ire of the gods. In the Cyrenaic region it is ordained by law to wage war against them every three years, to conquer them."

This Cyrenaic region is the present Barca and lies directly south of and opposite to Greece, and may possibly have been the breeding place of the Grecian locusts, as the more western Barbary region was of the Spanish, French and Italian; it being a matter of serious doubt whether they are really indigenous in any part of Europe. And it may be as well to state just here, that it is not a perfectly sure thing where the locusts came from that have appeared at different times in Europe. Hasselquist, for example, says that "they migrate, in a direct meridian line, from south to north, passing from Arabia, *which is the great cradle of them*, to Palestine, Syria, Carmania, Natolia, Bythnia, Constantinople, Poland, &c. This is evidently a fanciful and unreliable theory, as to their north and south flight, but still it throws a shade of doubt on the origin of the Danubian or neighboring Russian locusts, which is more generally located in northwestern Asia.

Passing from the north to the south in Africa, Dr. Shaw states that a space of 2,000 miles was covered with them at one time; and travelers like Drs. Barth and Livingstone speak of meeting them in the interior. The islands of Madagascar, Mauritius and Bourbon on its eastern coast, which lie beyond the Mozambique Channel, are visited in the same manner as are the Canaries on the west.

Herodotus speaks of a very numerous people, called Nasamones, who were known as locust-eaters. Their abode was in Cyrenaic

region (or Barca.) In the summer, he says, they would leave their cattle on the Mediterranean sea-coast and go up to Augila, some distance to the south, to procure locusts and dates. When they caught a quantity of them they dried them in the sun, and then having ground them to powder they would eat them with milk. Augilah bears the same name at the present day. It is a region of sand hills, with an oasis of the same name near by. Their repairing to that place to procure them indicates that the locusts were at home there in the days of Herodotus, more than 400 years before Christ.

If we pass the Dead Sea into Asia we find Arabia only Africa over again on a smaller scale, so far as the locust is concerned. It has the credit of being the source of supply for all the neighboring countries round about it, Africa not excepted.

Tristram says: The locusts of Egypt always came into that country from the East, and into Syria from the East and South-East, being in fact nurtured in the wilds of Arabia. "When it was morning the East wind brought the locust." "The locusts always come with the wind from the country of their origin, and this, as all observers attest, is with a south and southwest wind into Persia, and with an east wind into Egypt. Those that desolate Southeast Europe come with a north and northeast wind from the Ukraine." From these extracts it might be inferred that the locusts of Egypt, Palestine, Syria and Persia, all have their home and origin in Central Arabia. Nor do I remember anything directly contradictory to this, except that the Arabians sometimes say their own locust comes from beyond the Persian Gulf to the east of them. Though the subject of origin is the one I am at present investigating, I desire to call attention to the agency of the winds noticed by this author. "*The locusts always come with the winds from the country of their origin.*" A very pregnant and suggestive sentence in connection with the example given. I doubt whether there is any part of the researches on the subject likely to be more fruitful in results than those derived from the thermometer and the weather-vane. Suppose we know that they have had two hot, dry seasons along the mountains west and northwest of us, and the prevailing winds the following July and August should be from the west, what bearing would such a coincidence have upon the locust question in Minnesota, Nebraska and Kansas?

In Asia they abound to a greater or less extent all along and below the great east and west ranges of mountains from Asia Minor on the western side, to the island of Formosa in the Eastern Pacific Ocean: that is to say, over one-fourth the entire circum-

ference of the globe. In the last-mentioned place we are told that in the year 1645 their numbers caused such a famine that 8,000 persons perished of hunger. Returning toward the west and crossing to the north of the Altai range, we come to a very important region, as it is surmised to be the source of the scourge that has so often desolated Southern Russia, Poland, Hungary and the lower Danubian Provinces.

Here we have arrived in countries bearing a much closer analogy to our own, and not dissimilarly situated with respect to the subject of this review. In reading the account of their invasion and progress through those countries in 1747 and 1748, as published in the journals of that day, one is strikingly reminded of the dispatches that came up from the southwestern counties of our own state in 1873, heralding their progress from station to station, from the southwest to the Minnesota river.

As the years 1747 and 1748 were memorable ones in the history of the locust in Europe, I will give a few extracts from the journals of that time. The reader should bear in mind that the scenes here described were not in the deserts of Arabia, or Tartary, or America, but in the central part of populous, civilized Europe.

First. "HUNGARY, JUNE 9, 1748.—The misery is hourly increasing. There is no longer grass to feed the kine, and instead of it the locusts are covering the fields knee deep."

JUNE 28TH.—"The locust has appeared on the Danube and the Theisse (Hungary) in such numbers that they are reduced to the direst necessity. It is all over with the harvest."

JUNE 30.—KLAUSENBERG (in northeastern Hungary).—"The locusts have fixed particularly on the banks of Marasch (Maros, a river running from the Carpathians 400 miles through Hungary parallel to the Danube, but in the opposite direction, west, and emptying into the Theisse): they consume the produce of the whole land."

HARMANSTADT, July 10.—"Prayers are being offered up in all places where the quail and the locust have not been sent. The latter are coming from Carlsbad here. The vineyards are alone untouched by these insects. Every other thing which they meet with on their march, the herbage, the forest leaves, and even the bread in the houses, are booty and food for them."

As Carlsbad is 50 or 100 miles south of Klausenberg, and Harmanstadt a like distance south of Carlsbad, it appears that they were moving in a southern direction from that place.

HERMANSTADT, July 24.—"To-day they have poured in on us

in myriads. Six thousand men sallied forth with flails and other utensils, but all in vain. A hussar coming from the plague committee, though on horseback, was obliged to dismount and halt for three hours, until the inhabitants drove them from the spot."

We have the same story coming from Asod (Hungary) from another source.

WARSAW, July 17th.—"From Podolia, Volhynia and Ukraine, (Southwestern Russia-Poland, by the Bug and the Dniester,) come terrible accounts of the locusts, they cover the country for miles, and are heaped up a foot high."

WARSAW, AUG. 15.—(This is 400 or 500 miles north of where we hear of them in Hungary.) "The locusts are within four miles of us. A few of the vanguard ushered in the rest, but none have reached the city. * * The travelers who come hither are obliged to walk knee deep among them and endure a dreadful stench."

AUG. 22ND.—"They are now in the neighborhood of Breslau, the chief town of upper Silesia, on the Oder. On the 20th, an incredible multitude arrived in Lampersdorff; these they formed in column, and taking flight about noon, continued their passage about four hours over the forest of Minchen. Having passed the Oder, they settled in the country about Ohlan. On the 23d, another swarm came to Patchkau, and fell upon two gardens; being a little straitened in their quarters, they lay one upon the other in heaps to the height of one's knee. * * A third prodigious swarm passed Lorschdorff in the evening. On the 24th, they passed by Schonbrun, Priebron and Siebenhuben, and at length took up quarters in the village of Datzdorff, where they lay one upon the other a full quarter of a yard high. * * * They made their retreat by Arnsterberg, and then passed through the country of GLATZ into BOHEMIA."

BRESLAU, AUG. 30TH.—"The dreadful plague of the locust spreads more and more in this province. It is observed that the several swarms which lighted on the divers districts are only detachments from the grand body, to which, after foraging a while on the right and left, they repair. You can't conceive the noise made by these insects, as well in their flight as when they rest on the ground. On the 23d and 24th, great quantities fell in the district of * * *. On the 25th, they took their flight toward the town of Brieg (further up the Oder, to the south), forming a cloud several miles in length, and darkening the sun, so that at a small distance travelers could not descry the town. They were at Neurdorff on the 26th. Yesterday the main body of the invincible

army took their flight by Heidersdorff to Zothen. Beside the destruction they make everywhere, they leave a great stench behind them."

Much more of interest might be added, but this much may suffice to give some idea of this remarkable event, which attracted the attention of all Europe at the time. In these two years they spread over a large part of southeastern Europe, coming in great numbers as far west, at least, as Bohemia and the upper valley of the Oder in Prussia. Scattering bands of the same grand army were said to have passed over the Baltic into Norway and Sweden, in 1749, and there are several curious mentions of others that went so far as the British Islands. To add more of reality to this statement, I quote from *The Gentleman's Magazine*, of July 31st, 1748: "A swarm of locusts lately fell near Bristol, much resembling those that fell some time ago in Transylvania (Hungary), and now again ravage that country. A sort of locust, also, has done great damage in Shropshire and Staffordshire, by eating the blossoms of apple and crab trees, and especially the leaves of oak trees, which look as bare as Christmas. All three of these places named are on the western coast of England. From the description, they (the locusts) appear to belong to the species *Edipoda Migratoria*, one of the most dreaded kinds; the same that devastated Palestine in 1865."

Aug. 5.—The same authority says: "Numbers of locusts (discovered the hot, sultry day before in the clouds by the help of glasses) were found in St. James Park (London) and adjacent places."

Aug. 23, 1748.—A gentleman from Rochester, the extreme southwestern shire of England, writes: "The frequent accounts from abroad (Poland, Hungary, &c.,) concerning the locust, together with their appearance in some parts of England, particularly near Rochester, (which, upon inquiry, I find to be the fact,) occasions my troubling you with the following:

"The first discovery of them was made by the workmen in mowing a field of oats, near Chatham. Some of them were brought to me by the laborers. It is surprising with what quickness they devour cabbage-leaf, lettuce or other herbage. They have six legs, the two hindmost being largest, enables them to spring like our common grasshopper, though with more strength and to a greater distance." There are accounts of their appearance in other places in England in this season of 1748, and the people seemed to have taken it for granted that they were the Black Sea locusts. They

were not the "common grasshopper," but something different. Why should they happen to appear in England the same season they had so extensively overspread the southeastern portion of Europe? Is there, or may there not be, after all, certain occult influences at work, be it climatic, atmospheric, or something else, whereby the native species may suddenly become gregarious and destructive, passing in a single season through phases of metamorphosis or transformation which in higher organizations can only be effected gradually through a long space of time? Or rather, may not the countless myriads which we see in locust years be but the result of a fortuitous concurrence of accidents favorable to insect life and unfavorable to that of their natural enemies?

It is quite possible that all years would be locust years like 1747 and 1748 in Europe and 1873-4-5-6 here, were the same meteorological conditions to continue, and the causes of their destruction still be held in abeyance.

The question of the origin of the locusts as they appear in different localities is more interesting and important than any other connected with the subject: for how are we going to contend with an enemy when we know not from what quarter he may assail us, or whither or not there be any limit to his power of levy. To give the supposed origin of the Russian Black Sea locust, I quote *Sieur Beauplan's History of Ukraine*. He says: "I have seen the plague for several years, one after another, particularly in 1645 and 1646, (just 101 years earlier than the one above described.) Those creatures do not come in legions, but in whole clouds, five or six leagues in length, and two or three in breadth, and *generally come from toward Tartary*, which happens in a dry spring: for *Tartary and the countries east of it*, as Circassia, Bassa, and Mingrelia, are *seldom free from them*."

While desiring to avoid overloading these pages with long quotations, yet the following from Mouffet is, in several respects, so valuable and suggestive that I cannot refrain from introducing it here. It contains, in a short space, more information about locust invasion in Europe, in the beginning of the Christian era, particularly in Italy, than any I have met with. This is the more interesting to us as the countries mentioned bear a pretty close resemblance to our own, not only in climate and latitude, lying as it does between the 38th and 47th parallel, but also in reference to the supposed native homes of the locust. I call particular attention to the origin of the swarms as given by this author.

"In what manner God, by means of those insignificant insects, punished the stubbornness and hardness of heart of King Parrho

or Pharaoh, is clearly shown by the tenth chapter of Exodus, and is an old story in the churches, and even in the public streets. In the year 170, before Christ, nearly all the pastures were covered with, as it were, clouds of locusts, and 100 years after that a great swarm of them covered the whole territory around Capua—*Julius Obsequens*. In the year 181, after Christ, while a war had been progressing for a long while throughout Illyricum, Gaul, and Italy, and had been finally checked some how or other, in order that nothing might seem to be lacking to the punishment of wicked peoples, locusts, infinite in number and far greater than others, consumed all the herbage everywhere. In the year of our Lord 591, while Agilulf was king of the Longobards, an immense swarm of locusts grievously afflicted the country about Trent. These are said to have been brought by force of the winds from Africa. Nevertheless, the greater part of them were submerged in the sea by storms. But they were no less injurious and deadly to the Italians, (on that account,) for, rolled up by the waves on the shores of Cyrae, they caused among the inhabitants such a disease by their pestilential exhalation and odor, that Julius writes that 800,000 men and cattle perished by the pestilence. In Venice, likewise, and in the territory around Brescia, not far from Milan, so pitiful a famine ensued, from the loss of the crops, (for the locusts had destroyed everything) that in the year 1478, (when this happened) over 30,000 people died. Likewise in the years 593, 693 and 811, locusts flying from Africa, after a severe drouth, devoured the plants and herbage and bark of trees, whence followed a great famine, such as the author of the *Naumachia* elegantly describes in these verses.

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Nor has Gaul (France) been free from their teeth (!) and their gluttony, but in the years 455, 874, 1337, 1353, 1374, was wretchedly depopulated, and lost very many, even at times a third part of its citizens, cut off by lack of food and consumed by the ensuing pestilence. These generally had six wings, (!!!) and were wafted thither from the east. But at last driven into the sea of Britain by force of the winds, they were overwhelmed by the waves, then driven back on to the beach by the tide they infected the air, and produced a pestilence no less cruel than the famine that they had just been passed through—*Otho of Frisingen*. Moreover, in the year 1475 they devastated nearly all Poland. In the year 1536 innumerable swarms of locusts were borne by the force of the winds from the Euxine sea into that part of Sarmatia which the moderns call Podolia; these changing their camping grounds in

military fashion, consumed the whole territory in which they made their daily or nightly halts. These being of unusual magnitude, were destitute of wings at first, afterwards, as their wings grew they flew about at will and stripped even the trees of—what can I say—of leaves, blossoms, and even of bark. Afterwards wandering through Germany, they made their way even to the territory of Milan, and when that had been consumed, returned to Poland and Silesia. Finally, in the month of November, (for they lived as long as that,) stupified apparently by the cold, they produced a huge stench, and had they not served as food for hogs and wild swine, they would have afflicted the Germans as well as the Italians, with a most severe pestilence, no less than with famine. In the year 1543, the locusts inflicted very great loss on the provinces of Misnia and Marchia, at which date they were so thick in the Lucanian territory that they crowded together to the depth of more than a cubit—*Jacobus Eckcelius*. Every one knows how much damage swarms of locusts inflicted in the fields of Arelate (Arles.) Likewise while writing this, we learned that the people of Spain were afflicted with a great number of locusts brought from Africa. They flew through the air like military bands, and made the atmosphere dense. But the people, at the sight of them, ring bells, fire cannons, frighten with trumpets, make noises with brass kettles, throw sand in the air, in short, try all means by which they might be driven away. But the result did not correspond to their wish; and at last giving over their useless labor, they perish everywhere from the famine and putrefaction—as we have been informed by sailors and pilots who barely escaped that calamity. Entropius in his fourth book makes mention of very big locusts which had been seen not far from the territory of the Romans, to the greatest wonder and stupefaction of beholders, and so formidable to the inhabitants and so voracious, that they shuddered at the very sight of them. Hence we ought to infer that these little animals occupy not the least place among the powers and armies of God, and that they have been sent forth when He would punish the sins of men, or avenge contempt for His law."

It will be noticed in this extract what is commonly observable elsewhere, that the origin of the Spanish and Italian locust is uniformly ascribed to Africa; and the years of their grand movements are generally those of greater or less oppressive drouth. We discover, also, that there is no part of this garden of the world, Italy, but has at some time or other been afflicted with locusts, from Lucania, a province in the extreme south, to the city of Trent, on the Adige, up among the Alp-mountains, on the north.

I have given the above extracts at some risk of appearing prolix, to an indifferent reader; but it is quite impossible to interest those who have no mind to know. I wish to impress it upon those who never saw a locust that such an animal does exist; and upon those who have seen more than enough of them, that their losses are not without precedent, but that for hundreds and thousands of years locusts have ravaged the garden spots of the world,—such as the fields of Capua, whose luxuriant yields once ruined the armies of Hannibal, or Cyrenaic Barca, the fabled seat of the Hesperian gardens.

I have dwelt upon the European locust, not because they are worse or as bad as in many other places, but because we live in the Europe of North America; and the worst that has ever happened in any part of this country is only a repetition of what has repeatedly been witnessed there.

I have striven to learn the exact localities where they have been, and the countries from whence they came; for their origin and what the conditions are that cause them at certain periods of time to multiply so prodigiously are the great problems first to be solved.

If it be true that their natural breeding-place is among mountains, highlands or plateaus, of course they must always be found within striking distance of these places, and when they quit them, whether it be by accident or from natural desire or instinct, they do seem to affect the plains, the fertile valleys and broad level deltas of rivers. Need I refer to the valley of the Nile? Take the localities in Spain, Italy, Hungary, Poland and Russia, already mentioned.

The country from the Appennines to the sea, for a long distance about Capua, is a plain, almost as flat as the Pontine marshes nearer Rome. Speak of Lombardy, and it is always "the plains of Lombardy," and it is a plain, as its name implies. Cross the Cottian Alps to the west of this, and we are in another locust region, and another extensive plain, Languedoc and Provence, at the mouths of the Rhone, a country that might pass for a section of Africa. Hungary may be described as almost wholly a plain, sloping toward the Danube from the semicircular rim of mountains on the north. Pass eastward through the "Iron Gates" of the Danube and into Wallachia and Moldavia, Bessarabia and Bulgaria, and we have another of the greatest river plains in Europe. *Podolia*, in Russian Poland, that never made much of a figure in any but a locust history, is for the most part a fertile level plain.

The whole of Poland, except in the south, is an extended plain, and Russia, west of the Ural mountains, is pretty much all an immense plain, the southern part being the finest part of Russia, and a locust country *par excellence*. All that part of it extending eastward from the Black Sea, lying above the sea of Azof and the Caspian, on to the Ural mountains, is little better than a desert, being level, dry and barren, and abounding in salt lakes. But after all, what is there certain about this? What is the exact agency of deserts or of mountains? High mountains produce deserts by straining the moisture from the atmosphere. They exist side by side in some localities as a matter of necessity. The deserts must be passed over if the locust is to live at all. It is quite possible that he is only more destructive in the populous and fertile valley regions because a greater population are affected, and there is more there to be destroyed. When the locust once acquires wings, he moves; he does not seem to exercise much judgment whether it be from plenty to want or the reverse. He will move from a desert country, as east of the Rocky Mountains, to a fertile one, and he tries to move or is moved by the wind right back again into the same desert, the next year more often than otherwise, this being his cycle of migration—unfortunately, for the last four years unswung.

After having traversed the ground thus far, the question arises: what inferences are to be drawn from the facts obtained?

The subject is difficult to cope with, from the absence of anything like scientific accuracy in the observation of facts as given in the earlier records. Nevertheless, a few general ideas are suggested in the midst of this chaos, which assume a certain degree of prominence and fixity, among which are—

First. That there are certain portions of the globe where the locust exists *en permanence*: where he has flourished from age to age in unending succession, and that the type of such a region in the eastern hemisphere is found in Arabia and northern Africa.

Second. That there are other portions where, practically speaking, it does not exist at all, the type of which is found in the north of Europe and the British islands.

Third. That there are regions intermediate between these which are liable to be overrun by occasional migrations from the natural parent hives. And the type of these countries in the same hemisphere is the whole of Southern Europe from Gibraltar in Spain, to the Ural Mountains in Russia. The analogy of any given country in geographical and climatological conditions to any

one of these will most likely determine the question as to which class it belongs, and its comparative liability to locust incursions.

Applying this standard to the eastern portion of the United States, it is at once apparent that the region belongs neither to the first or third of the above classes. Our climate bearing no resemblance to either Southern Asia or Northern Africa, we do not breed locusts in any sense as they do; and being so far removed from their natural habitat, the country east of the Mississippi river may be said, in general terms, to be not afflicted with them at all. In this, of course, I make no account of certain comparatively harmless species which certainly do exist, but which bear scarcely more resemblance to the migratory locust in their destructive capacity than does the common house cat to the wolf, the lion, or the tiger.

The next question is, have we any country in the United States analogous to that which is included by, or borders upon the Altai, the Caspian and Ural regions in Asiatic Russia—the supposed starting point of the migration into Eastern Europe? The answer to this is, that it seems to be the opinion of some who are the best informed on the subject, that we have. Prof. Chas. V. Riley, the distinguished Entomologist of the State of Missouri, has announced the opinion that the locust has such a native home in the Rocky Mountains. I prefer to give this opinion in his own words, as it stands in his Seventh Annual Report. He says: “There is some difference of opinion as to the precise natural habitat and breeding place of these insects, *but the facts all indicate* that it is by nature a denizen of high altitudes, breeding in the valleys, parks and plateaus of the Rocky Mountain region of Colorado, and especially of Montana, Wyoming and British America. * * * My own belief is that the insect is at home in the higher altitudes of Utah, Idaho, Colorado, Wyoming, Montana, Northwestern Dakota and British America. It breeds in all this region, but particularly on the vast hot and dry plains and plateaus of the last-named territories, and on the plains west of the mountains, its range being bounded on the east, perhaps, by that of the buffalo grass.”

Again in his eighth report published at the commencement of the present year he reiterates the same opinion in this wise:

“Having carefully weighed all that has been written on the subject during the year, and eagerly sought all information that would throw light upon it, I am firmly convinced of the general truth of the views enunciated under this head in my last report. In that country (same as above) alone does it come to perfection for a series of years, and in that country alone can it become so

prodigiously multiplied, and be borne by the wind to such distances as to over run the country already indicated, where it is not indigenous, and reach as far east as it did in 1874. To this end a combination of favorable conditions, that only occasionally occur, are necessary."

In another portion of the same report, however, he does not hesitate to say that, "this whole subject of the original source of the swarms that at times lay our fertile valley country under such severe contribution, *is yet somewhat obscure*, and should be investigated by the government." It would seem as though the most "firmly convinced" were not without their misgivings considering the slender stock of facts in possession. And so, finally it appears that while in Europe they have never yet found out to an absolute certainty where their locust came from; in this country, also, the whole subject of their origin is veiled in a certain obscurity. We have come to know at last how little we do know. The origin or habitat of the locust in this, as in other parts of the world, is still a matter of doubt.

The cause of their immense multiplication, at certain seasons, we do not know, though heat and drouth seems to be favorable, and cold and moisture unfavorable to it. The cause of their migrations—is it instinct, is it desire for food, do they take a certain direction in their flight from instinct or design, or are they only borne about at the mercy of the winds? Does superfluous vitality and hunger cause them instinctively to rise high in the air in order to spy out new lands, and do they go on repeating this until they either perish on the seas or arid deserts, or till their wings, with favoring wind, have borne them to fields of ravage? It has been said that they are the creatures of the plains and arid, sandy deserts. In Africa, Arabia, Russia and North America they are *obliged* generally to pass over desert tracts to arrive at the lands of fatness and fertility. Are these deserts most often their birth place or their grave—which? "They come from the desert." Were they born there or did they merely fly over? The great distance they have been met with out at sea, has been shown. What positive evidence is there that these deserts are not, to a certain extent, barriers against them, rather than favoring breeding grounds? It has been surmised that they have a cycle of migration, and fly back again to their Rocky Mountain haunts after visiting us. Have we a sufficiency of facts to establish this? This season they flew north, south, east and west, over our state, and are still with us, and unhappily not in the Rocky Mountains.

If it be said that I have traveled a long way to arrive at such

lame and impotent conclusions at last, my reply is: I am not responsible for the situation, and it is better not to attempt to fill our bellies with the east wind. It is no part of the duty of the Commissioner of Statistics to make original discoveries in entomology or any other science. It is not my fault that the thing is as it is, but it will be the fault of the generation, and its reproach besides, if it is allowed to remain as it is. All I have attempted is to make a survey of the ground in order to get at the situation and see how the thing stands.

The first thing to be done in any new enterprise is to find out what has been done, and then build or improve upon that.

The following table, prepared by A. S. Packard, Jr., will show at a glance the states and territories of the United States, and also of Manitoba, that have been visited by locusts since 1818.

The solidity of the columns of figures since 1872 will afford an indication of the extent and duration of the evil, and may suggest whether it be not time to take the matter in hand.

Manitoba.	Minnesota and Western Iowa.	Montana and Dakota.	Wyoming and Idaho.	Utah.	Colorado.	Nebraska, Kansas and West'n Missouri.	Indian Territory and Texas.	California.	Washington and Oregon.
1818	1818								1827 or '28
1819	1819								1834 or '35
	1820					1820 or '21		1838	
			1845				1845		
						1846?			
			1852	1852			1849		1852
		1855?	1855	1855	1855?	1855	1855	1855	1855
	1856			1856			1856	1856	
1837	1857			1857					
1858									
1864	1864	1864			1864				
1865					1865				
						1866	1866		
1867	1867			1867	1867	1867	1867		
1868				1868	1868	1868			
1869						1869			
1872									
1873	1873	1873	1873	1873?	1873			1873	
1874	1874	1874	1874		1874	1874	1874	south	
1875	1875	1875	1875		1875	1875	1875	Cal.	
	1876	1876	1876		1876	1876	1876		

What is wanted in this matter is investigation—facts, rather than dogmatism or theory. Facts can only be obtained by setting about it in a systematic and sensible way. They will not reveal themselves unsought. Six thousand years experience has settled that. It is amazing that men have been content so long to grope amid the darkness, with all the resources of science unapplied. A single year of investigation devoted directly to this specialty might change the whole aspect of the question.

A government like that of the first Napoleon would not have waited a second, third and fourth time for the wide waste and devastation that has occurred in California, Utah and the Northwestern States, before putting forth its full power to arrest the progress of the evil. We do not know; we have no sure foundation anywhere. Scarcely any proposition that has been promulgated when brought within the focus of critical analysis, will stand the test. Their native home in any part of the world, where is it? The limits of their range, who can tell? I have ventured to give Arabia and northern Africa as among its peculiar native haunts.

But there are writers, and those of eminence, too, who assert that even in Africa the locust is not indigenous, but came thence from the deserts of Arabia. Go to Arabia, and they say that they came from beyond the Persian Gulf. And, finally, we are referred to the deserts, of unexplored Tartary as their original and sole source, and that they probably came across Behring's Straits to this country with aboriginal Indians; which is about tantamount to an acknowledgment of total ignorance, as it is more than questionable if all the locusts in the world sprang from one Adam and Eve pair in far-off Tartary.

Again, they say, the locust can never pass the Mississippi river, because they have never been known to do so. A very good reason, but not conclusive. They have passed nearer it this season than they ever before, and a few hours of northwest wind would carry them all over northern Illinois. Their progeny might not flourish there the next season, but it is impossible to see why locusts hatched in central Minnesota, Iowa and Missouri might not pass that river in a few hours' time, the wind favoring.

But, they say in reply, that it does not follow because a man can jump a stream ten feet wide, that therefore he can jump one thirty feet wide. There could not be a better example of the difference between an illustration and a demonstration. The flaw in this parallel is that our lively, saltatory locust, being a jumper born, indulges largely in that kind of pastime. He is not obliged to clear his thirty foot stream at *one* leap, but can take just as many as he likes at his own convenient leisure. If he can fly from Tartary all over Europe, from Montana to Missouri, from Africa across the Mediterranean or half way across the Atlantic, why not across the Mississippi river?

I admit, however, the full force of the reasoning that never having passed a certain limit in the past is the best possible guarantee for the future. From the same line of reasoning I am also disposed to take a hopeful view of the present situation. The evil

in localities such as ours always has been, and therefore, probably always will be, but casual and transient.

Capua, Lombardy, Languedoc, Hungary and the Danubian Provinces already named in this article, still flourish and are among the richest agricultural districts in Europe. Bad as the locust has been at times in the last named provinces it has not prevented the last named provinces from having the finest wheat fields in the world, with Odessa for their capital city.

The potato bug, the chinch bug, the fly, the weevil, come and go, but agriculture advances, and will so continue. I have abundant faith that the science and energy of this people will be found able to grapple with the evil, when once fully aroused.

It is but proper to state that the field of investigation covered by this article is not what was originally intended, but selected with the view of avoiding, as far as could be anticipated, any retraversing of the ground likely to be occupied by the governors and scientific gentlemen who met at Omaha, November last.

The history of the locust in Minnesota since 1873 is contained in the report of the commission appointed by Governor Davis last year, and one of the members of that commission will most likely complete the record up to the present date. Though I had designed giving a synopsis of this, the report of the meeting of governors at Omaha, and the two reports of our local commissioners, precludes any such necessity.

Since writing the foregoing I have had the pleasure of hearing a portion of the forthcoming report of Professor Whitman on this subject, embodying his observation and research during the present season. Since hearing it I have all the more reason to be satisfied with not having touched upon those parts of the subject which he has presented with so much ability. I have great pleasure in recommending it for careful perusal, both at home and abroad, as a document replete with careful observations and pregnant suggestions. Observers and scientists who are investigating this question will find it to be an important addition to their treasury of knowledge.

DAMAGE BY LOCUSTS IN 1875.

Returns of damages to crops have been received from nineteen counties of the state for the year 1875. This is nine counties less than reported in 1874. Of the 28 counties that reported that year, the following ten counties failed to report for 1875: Chipewa, Clay, Faribault, Grant, Lac qui Parle, Lincoln, Polk, Rock,

Stevens and Swift, leaving eighteen ; the county of Le Sueur being added, makes up the nineteen. As before stated, the feeling in the spring was that the force of the plague was about spent, and there was an indisposition to dwell upon it. In several of the counties that did not report, the damage was too slight to amount to anything, so that the table will probably be a full exhibit of the damage in the state.

The following table gives the total damage to each crop together with the area :

TABLE SHOWING TOTAL DAMAGE BY LOCUSTS IN 1875.

	Acres.	Bushels.
Wheat.....	167,872	2,024,972
Oats.....	38,560	1,127,780
Corn.....	51,754	790,981
Barley.....	1,565	41,059
Rye.....	104	1,131
Buckwheat.....	658	16,450
Potatoes.....	2,023	180,886
Beans.....	527	7,971
	263,063	4,141,230
	Acres.	Gallons.
Sorghum.....	101	5,172
	Acres.	Tons.
Cultivated Hay.....	1,192	1,802
	Acres.	Pounds.
Hops.....	198	2,253
Flax.....	2,582	22,635
	2,780	24,888

The next table gives the total damage to all the crops as returned by counties, which show somewhat less than in 1874, and very much less in every item than the estimate made by the Grasshopper Commission.

Statement of Grasshopper Damages in the State of Minnesota in the year 1875.

COUNTIES.	WHEAT.		OATS.		CORN.	
	Damaged or Destroyed.	Estimated Loss of Crop	Damaged or Destroyed.	Estimated Loss of Crop.	Damaged or Destroyed.	Estimated Loss of Crop.
	Acres.	Bushels.	Acres.	Bushels.	Acres.	Bushels.
Becker	886½	16,092	175	5,896	35	1,141
Blue Earth	28,615	286,458	6,860	153,744	5,189	113,673
Brown	34,933	388,985	7,606	212,682	3,728	66,097
Cottonwood	9,759	150,610	2,358	88,241	3,087	62,288
Jackson	6,143½	76,405	1,855	61,944	1,510	31,037
Le Sueur	952	16,248	208	8,285	174	7,116
Lyon	2,310½	31,790	689½	30,766	840½	18,128
Martin	915	8,696	1,539	26,100	634	11,925
McLeod	1,630	27,389	372	13,368	732	22,074
Murray	3,346	59,099	762	28,699	825	23,474
Nicollet	29,940	482,344	6,549	221,150	6,939	222,342
Nobles	4,708	44,911	1,496	42,092	1,411	24,938
Otter Tail	1,028	5,628	132	1,939	32	1,871
Redwood	8,779	101,225	2,347	52,217	2,163	36,107
Renville	7,815	80,341	1,180	26,198	19,392	3,879
Sibley	7,632	114,627	1,987	63,852	3,070	85,940
Watonwan	9,424	133,449	2,426	90,282	2,002½	58,951
Wilkin	39	615	13	205	.....	.....
Yellow Medicine	17	60	6	120	.....	.....
Total	167,872½	2,024,972	38,560½	1,127,780	51,754½	790,981½

Statement of Grasshopper Damages in the State of Minnesota in the year 1875.—Continued.

COUNTIES.	BARLEY.		RYE.		BUCKWHEAT.	
	Damaged or Destroyed.	Estimated Loss of Crop.	Damaged or Destroyed.	Estimated Loss of Crop.	Damaged or Destroyed.	Estimated Loss of Crop.
	Acres.	Bushels.	Acres.	Bushels.	Acres.	Bushels.
Becker.....	48	1,374	3	90	4	130
Blue Earth.....	224	6,518	41	765	26	466
Brown	136	3,924	9	107	57	935
Cottonwood.....	89	2,436	1	40	35	747
Jackson.....	43½	1,033	.....	.....	1½	45
Le Sueur.....	1	30	7	165	3½	70
Lyon.....	15½	270	.....	.....	.....	.....
Martin.....	16	362	1	18	17½	207
McLeod.....	33	749	4	80	26	528
Murray.....	26½	910	.....	.....	21	255
Nicollet.....	263	8,932	12¾	145	107¾	1,390
Nobles	174	2,905	.....	.....	46	1,528
Otter Tail.....	4	112	.....	.....	.....	.....
Redwood.....	73	2,312	.....	.....	85½	3,860
Renville.....	40½	572	.....	.....	.....	.....
Sibley.....	280	5,346	26	421	169	4,320
Watonwan.....	73	3,095	.....	.....	62	1,974
Wilkin.....	16½	180	.....	.....	.....	.....
Yellow Medicine.....	.....	.....	.....	.....	.....	.....
Total.....	1,565¾	41,059	104¾	1,131	658½	16,450

Statement of Grasshopper Damages in the State of Minnesota in the year 1875.—Continued.

COUNTIES.]	POTATOES.		BEANS.		SORGHUM.	
	Damaged or Destroyed.	Estimated Loss of Crop.	Damaged or Destroyed.	Estimated Loss of Crop.	Damaged or Destroyed.	Estimated Loss of Crop.
	Acres.	Bushels.	Acres.	Bushels.	Acres.	Gallons.
Becker	54½	7,610	1	71	.....	.....
Blue Earth	124	8,225	13	230	4	183
Brown.....	203	7,267	39	490	1	20
Cottonwood	258	12,790	93	1,593	3	194
Jackson.....	61	6,284	42	278	.....	.....
Le Sueur .....	.....	.....	.....	.....	.....	.....
Lyon.....	80½	5,254	39½	588	.....	.....
Martin	5½	333	4½	39	2½	140
McLeod.....	30	1,870	3	52	.....	.....
Murray	58	5,800	17½	340	.....	.....
Nicollet.....	437	34,162	3	71	38	2,630
Nobles	65	1,959	100	1,192	.....	.....
Otter Tail.....	1	80	.....	.....	.....	.....
Redwood.....	113	5,157	56	1,046	.....	.....
Renville.....	149	7,453	.....	.....	4	230
Sibley.....	281	18,449	10	211	48	1,645
Watonwan	103½	8,223	106	1,770	½	130
Wilkin .....	.....	.....	.....	.....	.....	.....
Yellow Medicine.....	.....	.....	.....	.....	.....	.....
Total.....	2,028	130,886	527½	7,971	101	5,172

Statement of Grasshopper Damages in the State of Minnesota in the year 1875.—Continued.

COUNTIES.	CULTIVATED HAY.		HOPS.		FLAX.	
	Damaged or Destroyed.	Estimated Loss of Crop.	Damaged or Destroyed.	Estimated Loss of Crop.	Damaged or Destroyed.	Estimated Loss of Crop.
	Acres.	Tons.	Acres.	Pounds.	Acres.	Pounds.
Becker.....	1½	3	.....	.....	.....	.....
Blue Earth.....	965	1,286	.....	.....	.....	.....
Brown.....	53	156	10	80	.....	.....
Cottonwood.....	2	6	.....	.....	1,334	11,208
Jackson.....	.....	.....	177	2,037	.....	.....
Le Sueur.....	23½	30½	.....	.....	.....	.....
Lyon.....	.....	.....	.....	.....	.....	.....
Martin.....	5	8	.....	.....	105	646
McLeod.....	10	.....	11	136	.....	.....
Murray.....	15	66	.....	.....	.....	.....
Nicollet.....	47	90	.....	.....	.....	.....
Nobles.....	.....	.....	.....	.....	616	4,035
Otter Tail.....	7	10	.....	.....	.....	.....
Redwood.....	.....	.....	.....	.....	.....	.....
Renville.....	11	15	.....	.....	.....	.....
Sibley.....	53	132	.....	.....	.....	.....
Watonwan.....	.....	.....	.....	.....	527	6,746
Wilkin.....	.....	.....	.....	.....	.....	.....
Yellow Medicine.....	.....	.....	.....	.....	.....	.....
Total.....	1,192	1,802½	198	2,253	2,582	22,635

PRACTICAL SUGGESTIONS BY GOVERNOR PILLSBURY.

In the proclamation issued August 30, 1876, Governor Pillsbury gave in a compact form most of the known means of combating the locusts, the essential parts of which I print for information as follows :

First.—The crushing of the insects by rollers and other implements, and the catching of them by bags and traps during the season of copulation or mating, when by reason of their stupid and inactive condition they may be destroyed in vast numbers. This is the first and vital step towards their destruction, and can be resorted to immediately, the insects being in the condition named from about the middle of August variously until the approach of cold weather.

Second.—The plowing under deeply of the eggs and the thorough harrowing of the bare, dry knolls and comparatively small, warm spots where the eggs are deposited, so as to dislodge them from their cells or pods, which destroy their germinating power. New breaking being a favorite resort for such egg deposits, this mode of destruction is readily available in the ordinary course of farm work, for which purpose these operations should be delayed till as late a period in the fall as practicable.

Third.—Co-operative action for the preservation of the prairie grass until the proper season for its burning in the spring, by means of extended fireguards along township boundaries or other large areas, to be accomplished by means of plowed strips or by wide parallel furrows and the careful burning of the intervening space. The burning of the grass thus preserved, when filled with the young grasshoppers in the spring, has been found to be a very effectual means for their wholesale destruction.

Fourth.—The placing of loose straw on or near the hatching places, into which the young insects gather for protection from the cold in early spring, where they may be destroyed by firing the straw at the proper time. To this end straw should be carefully saved and not needlessly destroyed at threshing time.

Fifth.—The construction of deep, narrow ditches, with deeper pits at intervals, as a defence against the approaching insects in their infant condition. Into these the young, when comparatively helpless, accumulate in vast numbers, and perish.

Sixth.—The sowing of grain in "lands" or strips, fifty to one hundred feet wide, leaving narrow vacant spaces through which to run deep furrows and construct ditches into which the young grasshoppers may be driven and destroyed.

Seventh.—The catching of the insects at various stages, and especially when young and comparatively inactive, by means heretofore employed, and by such improved instruments and process as our experience may suggest.

Eighth.—And, finally, the driving of the winged and matured enemy from the ripening grain by passing over it stretched ropes continually to and fro, aided by annoying smoke from burning straw or other smudges, and by loud and discordant noises made by striking tin vessels, and by shrieking and yelling with the voice, which are said to aid in disturbing the pests and inducing their flight.

UNIVERSITY OF MINNESOTA.

COLLEGE OF AGRICULTURE—MINNEAPOLIS.

For the information of persons throughout the state who may not be aware of what provision has been made for giving instruc-

